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Aircraft Noise - Takeoff Flight Procedures and Future Goals

Bolt Beranek and Newman, Inc.
Cambridge, MA

Prepared for

Environmental Protection Agency
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U.S. Environmental Protection Agency
Office of Noise Abatement and Control

Under Contract No. EPA 68-01-4488

Prepared by:

Bolt Beranek and Newman Inc.
Cambridge, MA 02238

This report has been approved for general availability. The contents of this report reflect the views of the contractor, who is responsible for the facts and the accuracy of the data presented herein, and do not necessarily reflect the official views or policy of EPA. This report does not constitute a standard, specification, or regulation.

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16. ABSTRACT

The study was designed to develop and analyze an aircraft takeoff noise data base consisting of areas and populations, computed as a function of noise level, aircraft type, weight and takeoff flight procedure. Six aircraft, each at typical and maximum weight, were chosen to represent the range of civil transport aircraft and engine types. Six types of takeoff flight procedures were selected, three involving cleanup of flaps and leading edge devices before thrust cutback, and three involving thrust cutback before or during cleanup. Each of these procedures was initiated at 3 altitudes: 122, 305, and 610 meters, so that for each combination of aircraft and weight a total of 18 takeoff procedures were considered, for a total of 216 cases.

The data base developed in this report enable an approximate direct translation of results between various operational procedures and the certification test procedures. This translation methodology is developed through examples of the selection of trial goals and the development of their implications in terms of certification noise limits. The relative effectiveness of the various procedures was found to be highly dependent on two performance characteristics, takeoff climbout and noise reduction resulting from thrust cutback. For aircraft with high and intermediate climbout performance and with a high value of noise reduction with thrust cutback, the procedures having least potential noise impact involved maximum cutback, and, if cleanup were initiated prior to cutback, showed that it should be initiated at the lowest safe altitude

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1. SUMMARY AND CONCLUSIONS

Study Design

The study was designed to develop and analyze an aircraft takeoff noise data base consisting of areas and populations, computed as a function of noise level, aircraft type, weight and takeoff flight procedure.

Six aircraft were chosen to represent the range of civil transport aircraft and engine types. Three of the aircraft were chosen to have high bypass ratio engines and three were chosen to have low bypass ratio engines; one aircraft with each engine type for the 2-, 3-, and 4-engined aircraft categories. The aircraft with low bypass ratios were selected to represent early production FAR Part 36 Stage 1 noise performance, while the aircraft with high bypass ratios were selected to represent current and future production with Stage 2 or 3 performance. For each aircraft two weights were examined, maximum gross weight and a typical operating weight.

The aircraft represented in this study were selected to provide a range of performance characteristics which could then be examined to develop inter-comparison amongst procedures and performance characteristics. The performance characteristics for each aircraft have been derived from several sources. Therefore, they are not necessarily precisely those of the actual aircraft, a requirement that is unnecessary for the purposes of this study. However, the reader is cautioned that the comparisons amongst aircraft should refer only to comparisons among aircraft having the characteristics assumed in this study, and that such comparisons are not necessarily totally valid in all details when attributed to specific actual aircraft.

Six types of takeoff flight procedures were selected, three involving cleanup of flaps and leading edge devices before thrust cutback, and three involving thrust cutback before or during cleanup. These procedures are:

1a) cleanup before maximum cutback

1b) cleanup before maximum cutback and resume minimum cutback (climb thrust) at 914 meters altitude

2) cleanup before minimum cutback (climb thrust)

3a) maximum cutback before cleanup

3b) maximum cutback before cleanup and resume minimum cutback (climb thrust) at 914 meters altitude

4) minimum cutback (climb thrust) before cleanup.

Each of these procedures was initiated at three altitudes: 122, 305, and 610 meters, so that for each combination of aircraft and weight a total of eighteen takeoff procedures were considered. Thus, there are 216 cases contained in the data base (eighteen procedures times twelve combinations of aircraft and weight). Data for each of the 216 cases was computed for a straight ground track using the Noisemap computer program with its aircraft noise data based on existing values at the 305 meter slant distance, and modified to update the duration distance function.

The output data for each case consists of:

- contour length at 5 dB intervals from EPNL = 85 to 115 dB
- contour area at 5 dB intervals from EPNL = 85 to 115 dB
- population for three population density functions for each area
- total population exposed based on estimated number of runways in each population density category

- proportionate impact based on simplified level weighted population for a typical runway
- maximum noise levels at 450 meters slant distance
- noise levels along the ground track at 4700, 6500, 9200, and 12,800 meters from start of takeoff roll.

Comparison of Procedures

The relative effectiveness of the various procedures was found to be highly dependent on two performance characteristics, takeoff climbout and noise reduction resulting from thrust cutback.

The takeoff climbout performance of the aircraft in this study varied significantly with the number of engines installed in the aircraft. Aircraft with 2 engines had the highest performance, aircraft with 4 engines had the lowest performance, and aircraft with 3 engines were intermediate. The principal reason for this difference is the variation in the takeoff thrust-to-weight ratio with the number of engines, which is, to a large extent, the result of the one engine inoperative safety requirements of FAR Part 25.

The amount of noise reduction resulting from thrust cutback also varied significantly among aircraft with different engine types and with weight. For maximum thrust cutback the largest noise reduction, ranging between 7.4 and 10.7 dB, were associated with the B727-100 and DC9-10 aircraft, both powered with versions of the low bypass JT8-D engine, and with the DC9-80 aircraft which is powered with a higher bypass version of the same engine. Lower values, ranging between 3.2 and 4.5 dB, were found with the DC10-10 and B747-200, both powered with large high bypass ratio engines. The lowest values of 2-3.5 dB were found for the B707-320B powered by low bypass ratio JT3-D engines. For all aircraft, the noise reduction at the selected typical operating weights was greater than that at maximum gross weight.

The general conclusions relative to the potential noise impact for the *average* population distributions and to the procedures, as a function of these performance characteristics, are:

1. For aircraft with high and intermediate climbout performance and with a high value of noise reduction with thrust cutback:

   a) Maximum thrust cutback (procedures 1 and 3) has significantly less potential noise impact than does minimum thrust cutback (procedures 2 and 4).

   b) Resumption of minimum thrust cutback at 914 meters (procedures 1b and 3b) results in an increase in potential impact relative to no resumption, until the noise level beneath the aircraft is lower than the lowest value of concern (procedures 1a and 3a) or the aircraft has departed the populated area.

   c) Maximum cutback before cleanup (procedure 3a) has less potential noise impact than does cleanup before maximum cutback (procedure 1a) when both are initiated at an altitude of 305 meters. The reason for this result is that the noise levels beneath and to the side of the aircraft are much less for procedure 1a in the region extending between the location of its cutback and location of cutback for procedure 3a. This result is not changed when the amount of thrust cutback for procedure 3a is decreased from that allowed in FAR Part 36 certification to that recommended for normal operations by AC91-53. Procedure 1a is superior in all regions beyond the location of its cutback.

   d) Cleanup before maximum cutback (procedure 1a) has the least potential impact when the procedure is initiated at 122 meters, and produces increasing amounts of potential impact with increasing values of the initiation altitude. No similarly consistent variation with altitude was found for procedure 3a, although initiation at 305 meters was most often superior in terms of potential impact.

e) Maximum available takeoff thrust should be used during the first segment of takeoff to minimize noise impact and, at least for procedures 1a, 1b and 2, minimum flap settings should be employed where runway lengths are adequate for safety. When procedure 1a was initiated at 122 meters its potential impact was approximately the same as would be expected for procedure 3a initiated at 305 meters, but modified to comply with the recommendations for minimum thrust in AC91-53. Both of these procedures are believed to have less potential noise impact than do the current operating procedures.

2. For aircraft with intermediate and low climbout performance and with an intermediate value of noise reduction with thrust cutback there is only a small variation in potential noise impact amongst the procedures and no procedure was clearly superior in terms of potential impact.

3. For an aircraft with low climbout performance and with a low value of noise reduction with thrust cutback there was a small variation amongst procedures, with cleanup before maximum cutback (procedure 1a) initiated at 305 meters having less potential noise impact at the typical weight and maximum cutback before cleanup (procedure 3a) initiated at 610 meters having less potential noise impact at the maximum weight.

4. For all aircraft maximum available thrust should be used during the first segment takeoff to minimize potential noise impact.

5. For all aircraft, and for procedure 3a initiated at 305 meters, the contour area can be normalized to the difference between the EPNL value of the contour and the EPNL for maximum thrust cutback at a fixed slant distance of 305 meters. Additionally, with a few exceptions, the contour area for both procedures 3a and 4 can be normalized to the difference between the EPNL value of the contour and the EPNL value at the 6500 meter location. These normalizations should be expected to apply to other aircraft and weights beyond those in this study.

6. For all aircraft weight combinations and for procedure 3a, the functions of total *airport/runway* weighted population within contours of fixed EPNL values. and *airport/runway level* weighted population appear to be reasonably smooth functions of the associated EPNL values at the 6500 meter location.

These general conclusions are based on the average functions of population density as a function of distance from the airport. The data also suggest the following conclusions for application to specific airports:

1. For all aircraft with high and intermediate values of noise reduction with thrust cutback:
   - If the populated area is close to the airport, attain the maximum altitude before reaching the populated area, then initiate maximum cutback, and subsequently

resume climb thrust either after passing the populated area or when attaining an altitude where the noise on the ground is less than a selected value.

- If the populated area is far enough from the airport to allow completion of partial or complete cleanup before reaching the populated area (see Table 9), initiate acceleration and cleanup at the lowest safe altitude, then initiate maximum cutback at the beginning of the populated area, and subsequently resume climb thrust as above.

2. For aircraft with low climbout performance and with low values of noise reduction with thrust cutback, attain the maximum altitude before reaching the populated area, then initiate minimum thrust cutback and proceed to cleanup and climb.

Future Goals

The normal operational takeoff climbout procedures differ from those in used certification testing under FAR Part 36 in two important ways. First, the procedures recommended in the FAA Advisory Circular AC91-53 suggest initiation of the second climb segment, in which cleanup and cutback occur, at a fixed altitude of 305 meters. The certification test procedures allow the aircraft to continue initial climb to an altitude that is as high as possible before initiating a maximum thrust cutback to minimize the EPNL measured at 6500 meters from the start of takeoff roll. Second, the FAR Part 36 procedures allow a greater thrust cutback (to the thrust that is required for level flight with one engine inoperative, or a minimum of a 0.04 climb gradient) than do the AC91-53 recommendations (to the thrust that is required to maintain a minimum climb gradient of 0.012, 0.015 or 0.017 for 2-, 3- and 4-engined aircraft, respectively). Because of these differences, the EPNL values measured at the 6500 meter location in certification testing are generally lower than those measured in normal flight operations, particularly for 2- and 3-engined aircraft.

The data base developed in this report, including the correlations between the noise contour areas, populations and EPNL at the 6500 meter measurement location, enable an approximate direct translation of results between various operational procedures and the certification test procedures. This translation methodology is developed through examples of the selection of trial goals and the development of their implications in terms of certification noise limits.

From the analysis of these examples the following are concluded:

1. Although there are significant procedural differences between certification and normal flight operations the FAR Part 36 test procedure provides positive incentive to the designer of civil turbojet transport category aircraft to optimize all of the design factors for the engine, airframe, and their combinations which are relevant to the reduction of noise impact in normal flight operations. Furthermore, improving these relevant design factors with respect to noise is, except for installation of acoustic treatment, consistent with improving one or more of the performance parameters of an aircraft design.

2. The 6500 meter measurement location is the shortest distance from start of takeoff roll at which a large 4-engined aircraft at maximum gross weight may be expected to reach

an altitude of approximately 305 meters prior to initiating cutback. For 2- and the smaller 3-engined aircraft a measurement location at a shorter distance, such as 4700 meters suggested for business jet aircraft, would be adequate in this respect.

3. The differences in the FAR Part 36 Stage 3 noise limits between the limits for 4-engined and those for 2- and 3-engined aircraft, of 5 and 2 dB, respectively, are shown for an example of a hypothetical 220 thousand pound aircraft to be consistent with the differences obtained when designing for equal potential noise impact using procedure 3a and for equal noise control technology.

4. Attainment of a trial goal of Noise Exposure Forecast (NEF) 30 (day/night sound level (L_{dn}) of approximately 65) for a contour area of 3 sq. km. using procedure 3a would require that a fleet average aircraft meet takeoff noise limits that are approximately 9 to 11 dB below the Stage 3 noise limits) depending on the number of engines.

5. Attainment of this trial goal would mean that there would be negligible population expected within NEF 30, based on the average population density functions used in this study. However, because the airports with greater than average operations often have greater than average population densities and greater than average utilizations on some runways, a significant population could be expected to be found at a number of actual airports. If this population were to control the selection of a trial noise goal, the required noise limits are estimated to be 3 to

6 dB lower than in (4) above. Additionally, the use of procedures other than 3a might cause a further lowering in the required noise limits.

2. INTRODUCTION

Background

The noise resulting from civil aircraft operations at airports has plagued airport neighbors and airport operators since the introduction of turbojet aircraft in the late 1950s. The neighbors have suffered the noise impacts and the operators have been constrained in airport development largely due to the adverse public reaction to noise.

It is estimated [1] that in 1975 400,000 people resided in neighborhoods where the day-night sound level (L_{dn}) exceeded 75 dB and 5,150,000 people resided in neighborhoods where the L_{dn} exceeded 65 dB. It is predicted [1,2, and 3] that these numbers will be reduced to 150,000 and 3,000,000, respectively, by the end of 1985 due in large part to the Federal Aviation Administration (FAA) retrofit regulation [4]. However, it is also predicted that the next fifteen years to the year 2000 will see these numbers of exposed population reduced only slightly to 100,000 and 2,550,000, respectively. The predicted reduction [1, 2 and 3] is due to the introduction of new aircraft meeting the FAA's FAR Part 36 Stage 3 noise regulation [5], but is limited by the assumed slow retirment of existing noisier aircraft.

The general national goals [6] developed by the Environmental Protection Agency (EPA) for environmental noise are to:

- "Reduce environmental noise exposure of the population to an L_{dn} value of no more than 75 dB immediately, utilizing all available tools, except in those isolated cases where this would impose severe hardship."

- "Through vigorous regulatory and planning actions, reduce environmental noise exposure levels to L_{dn} 65 dB or lower, and concurrently reduce noise annoyance and related activity interference caused by intrusive noises."
- "In planning future programs concerned with or affecting environmental noise exposure, to the extent possible, aim for environmental noise levels that do not exceed an L_{dn} 55 dB. This will ensure protection of the public health and welfare from the adverse effects of noise based upon present knowledge."

As applied specifically to aircraft noise these goals [1]

> "are to confine severe aircraft noise-exposure levels greater than L_{dn} 75 dB around United States airports to the areas included within the airport boundary, or to areas which are otherwise being used in a manner compatible with this level of noise, and to reduce substantially the number and extent of areas receiving noise-exposure levels that interfere with human activity."

These goals are shared by both FAA [7] and the Department of Housing and Urban Development (HUD) [8]. However, as seen above, they will not be met for a significant number of people, even at the end of the next generation.

There are a number of actions that may be possible on an airport specific basis that can alleviate at least part of this problem. These actions include: optimization of flight tracks, runway utilization and flight procedures (throttle and flap management), with respect to population; noise abatement planning including use of nondiscriminatory noise limits; and land use management including soundproofing of residences. However, the long-range solution ideally requires the development of aircraft that are quieter than required today and implementation of flight procedures that minimize noise impact with consideration for fuel and other costs and no compromise with safety.

The majority of the national noise impact from aircraft operations results from the noise generated during takeoff operations. The major control for this noise is FAR Part 36 which today affects all new airplanes and after 1985 will affect almost all civil transport aircraft that operate in this country. However, the predictions [1, 2 and 3] of future population noise exposure indicate that aircraft meeting the Stage 3 noise limits will not be sufficient to meet the national goals. It is not intuitively evident what noise limits would be sufficient for meeting the national goals; nor are the interactions among population noise exposure, certification methodology, aircraft design and aircraft flight procedures completely understood.

Further, the throttle and flap management procedures for takeoff, currently recommended [9] by the FAA for use by the airlines in flight operations, differ from those used in the certification process. In many instances the certification process allows a greater cutback of thrust than does the recommended operational flight procedure. However, concomitant with the greater cutback is a reduction in the climb profile so that under certification the aircraft after thrust cutback covers a greater distance to gain an altitude than under the procedure recommendation. Additionally, under certification the aircraft is operated to produce minimum effective perceived noise level (EPNL) at a location 6500 meters from the beginning of takeoff roll, whereas under the procedure recommended for airline operations the minimization process begins at a fixed altitude above airport of 305 meters, independent of distance from start of takeoff roll.

These differences in procedures and the interactions with the spatial distribution of population with respect to airports, certification methodology and aircraft design need to be accounted for in the development of long-range goals for noise certification.

Purpose of this Study

The purpose of this study is to develop and analyze a data base that relates noise level, operational flight procedure and contour area and population; and to endeavor to link this data base to FAR Part 36 certification test procedures and noise limits. The study includes six flight procedures, with the initial climb segment terminated at each of three altitudes, for a total of 18 procedures for each aircraft-weight combination.

The study uses six aircraft models, each at two takeoff weights, maximum and typical. The models selected to include 2-, 3- and 4-engined configurations with both low and high bypass engines. The specific data for each model is not intended for detailed comparison of relative performance of specific aircraft because the basic performance data for the aircraft are from generalized sources. Rather, the range of performance characteristics, attributed to these specific aircraft models for use in this study, is intended to provide information on the interactions between generalized aircraft performance characteristics and the parameters in the data base.

Content of this Report

This report contains two major sections, Methodology and Results. The Methodology section has a detailed description of the study design, the operational flight profiles, the development of noise contours and the derivation of the population data base used for this study. The Results section contains a detailed analysis of a baseline flight procedure, examines the relative potential impacts of various procedural alternatives and discusses some of the implication of these results with respect to the certification test procedure and to the possible development of future certification goals for noise limits.

3. METHODOLOGY

This section reviews the overall study design and then provides more detailed discussion of the flight profiles, development of noise contours, the derivation of population data base and rationale for selection of specific measurement locations under the flight path.

3.1 Study Design

The study was designed to develop and analyze an aircraft takeoff noise data base consisting of areas and populations, computed as a function of noise level, aircraft type, weight and takeoff flight procedure.

Six aircraft were chosen to represent the range of civil transport aircraft and engine types. Three of the aircraft were chosen to have modern high bypass ratio engines and three were chosen to have the older low bypass ratio engines; one aircraft with each engine type for the two, three, and four engined aircraft categories. The aircraft with low bypass ratios were selected to represent early production stage 1 noise performance, while the aircraft with high bypass ratios were selected to represent current and future production with stage 2 or 3 performance. For each aircraft two weights were examined, maximum gross weight and a typical operating weight.

Table 1 identifies the aircraft in each category and presents selected typical characteristics. The typical operating weights for use in this study were selected primarily on the basis of CAB 1977 operating data, on a fleet wide average aircraft basis with an allowance for fuel load. For these aircraft the EPNL at 305 meters (1000 ft.) and takeoff thrust ranges from 102 to 115 dB, with the aircraft that have low bypass ratio engines having levels that are 7-9 dB higher than those with high bypass ratio engines. The slant distances from the aircraft at full takeoff power to an EPNL of 85 dB range from 1570 to 3300 meters.

TABLE 1. SELECTED CHARACTERISTICS OF STUDY AIRCRAFT

AIRCRAFT CATEGORY	AIRCRAFT TYPE	Max Gross Takeoff Weight (1000 lbs)	CAB 1977[10] Avg. Length (stat. mi.)	CAB 1977[10] Avg. Payload (1000 lbs.)	CAB 1977[10] Avg. Payload Factor %	Typical Oper. Wgt. (1000 lbs)	NOISE: Air to Ground at Takeoff Thrust	
							EPNL at 305 Meters Slant Distance	Slant Dist. (Meters) to EPNL = 85
2 engine, low bypass ratio	DC9-10	90.7	300	9.7	51	80	109.0	2800
2 engine, high bypass ratio	DC9-80	140.0	430	11.4	52*	112	102.2	1700
3 engine, low bypass ratio	B727-100	160.0	560	13.0	53	135	111.0	3300
3 engine, high bypass ratio	DC10-10	440.0	1280	34.0	47	370	102.0	1570
4 engine, low bypass ratio	B707-320B/C	333.6	1530	24.0	51	260	115.0	3050
4 engine, high bypass ratio	B747-200	775.0	2200	53.3	49	625	108.0	2590

*Avg. of B727-100 and DC9-10.

Six types of takeoff flight procedures were selected, three involving cleanup of flaps and leading edge devices before thrust cutback, and three involving thrust cutback before or during cleanup. These procedures are:

1a) cleanup before maximum cutback

1b) cleanup before maximum cutback and resume minimum cutback (climb thrust) at 914 meters altitude

2) cleanup before minimum cutback (climb thrust)

3a) maximum cutback before cleanup

3b) maximum cutback before cleanup and resume minimum cutback (climb thrust) at 914 meters altitude

4) minimum cutback (climb thrust) before cleanup.

Each of these procedures was initiated at three altitudes: 122, 305, and 610 meters, so that for each combination of aircraft and weight, eighteen takeoff procedures were considered. Thus, there are 216 cases contained in the data base (eighteen procedures times twelve combinations of aircraft and weight).

The maximum cutback in procedures 1a and 1b is intended to meet the rules of FAR Part 25 [11], whereas the maximum cutback in procedures 3a and 3b is intended to meet the less stringent rules of FAR Part 36. Procedures 1b and 2 are similar in concept to the Northwest Airlines/Airline Pilots Association (NW/ALPA) procedure, and procedure 4 is similar in concept to the Air Transport Association (ATA) procedure. Procedure 1b, initiated at 305 meters, is recommended for aircraft powered by engines with low bypass ratio engines and procedure 2, initiated at 305 meters, is recommended for aircraft with high bypass ratio engines by the FAA Advisory Circular 91-53 [9].

Data for each of the 216 cases were computed for a straight ground track using the Noisemap computer program [12] with aircraft noise data based on the values at 305 meter slant distances in reference 13, but modified to update the duration distance function.

The basic study range of noise levels is 85-115 EPN dB. The 85 EPNL contour has been chosen as the lowest value for investigation because it appears to be in the vicinity of a satisfactory flyover noise level, and is already attainable within a reasonable distance from the airport by the most advanced smaller jet aircraft. The attainment of 85 EPNL implies attainment of maximum A-weighted sound levels between 70 and 75 dB at typical source-receiver distances of more than 305 meters. Such levels are similar to those measured for automobiles under low acceleration at distances of 15 meters. They also bracket the division between regions found to be "quiet" and "acceptable" in a British Survey of response to single event noise. [14] The effective number of events per day, each having an EPNL of 85 EPN dB, could be 200 to produce a noise exposure forecast (NEF) value of 20 ($L_{dn} \approx 55$), which is the EPA long-range national goal.

The output data for each case are summarized in Appendix A, and consists of:

- contour length at 5 dB intervals from EPNL = 85 to 115 dB
- contour area at 5 dB intervals from EPNL = 85 to 115 dB
- population for three population density functions for each area
- total population exposed based on estimated number of runways in each population density category
- proportionate impact based on simplified level weighted population for a typical runway

- maximum noise levels at 450 meters slant distance
- noise levels along the ground track at 4700, 6500, 9200, and 12,800 meters from start of takeoff roll.

3.2 Flight Profiles

The takeoff flight profiles were defined to an altitude of 3048 meters (10,000) feet using the methods of reference 15. The altitude of 3048 meters was chosen to be sufficient to cover the entire range of EPNL of 85 dB and above for minimum cutback engine thrust (climb power) for all of the aircraft. The profiles assume a sea level airport and standard day temperature and pressure. They were calculated in several segments, depending on the procedure, but at least considering segments between the altitudes of 0, 305, 914, 1676, 2286 and 3048 meters, within which the effect of altitude on pressure were averaged in determining net thrust (F_n) and net thrust normalized by pressure (F_n/δ).

The generalized diagram of the profile segments as they are related to the 18 procedures is contained in Fig. 1. The first segment consists of the takeoff roll and the initial climb. The takeoff roll, denoted as subsegment A, extends from the start of takeoff roll (A_1) to the intersection of the initial climb subsegment B with the ground plane at point B_1. This simplified description eliminates the unnecessary details of the profile between the moment of liftoff through retraction of landing gear and acceleration to initial climb speed. The initial climb subsegment B extends to C_1, which occurs at the altitude of either 122, 305 or 610 meters (400, 1000 or 2000 feet), depending on the procedure. The second segment, intermediate climb, extends to an altitude of 914 meters and may have several subsegments; i.e., C_1 to C_2, C_2 to C_3 etc., as required for procedures 1a, 1b, 2

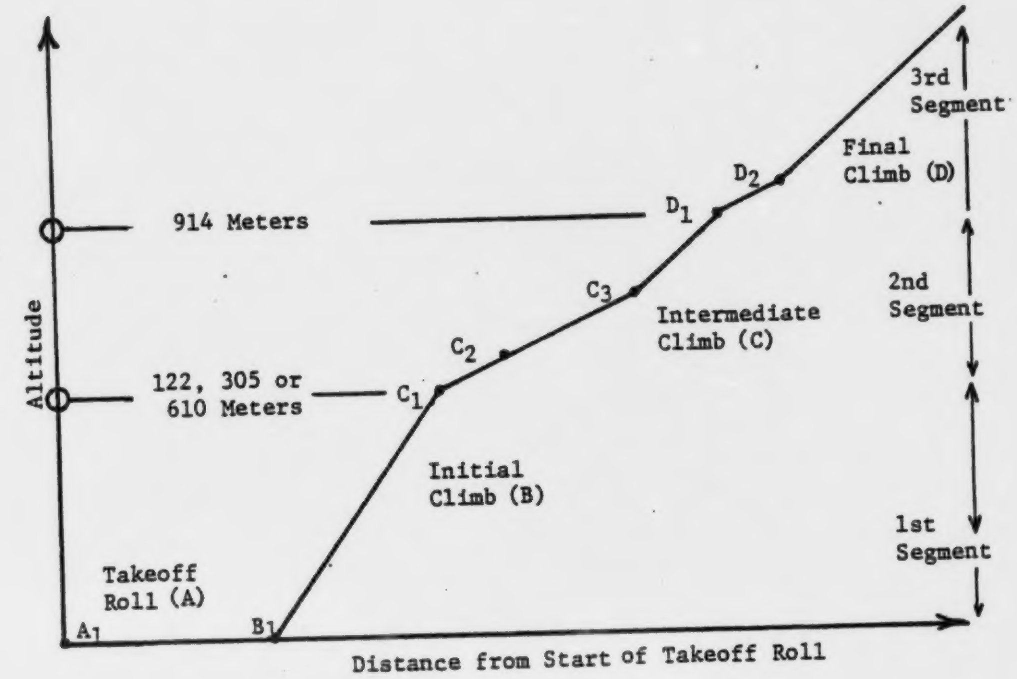
3rd
Segment
Final
Climb (D)
D2
D1
914 Meters
C3
Intermediate
Climb (C)
2nd
Segment
C2
Altitude
122, 305 or
610 Meters
C1
Initial
Climb (B)
1st
Segment
Takeoff
Roll (A)
A1
B1
Distance from Start of Takeoff Roll

FIG. 1 IDENTIFICATION OF TAKEOFF PROFILE SEGMENTS.

and 4, or none as required for procedures 3a and 3b. The third segment, final climb, extends upwards from D_1 at an altitude of 914 meters and may have more than one subsegment, depending on the requirements of the procedure. The additional subsegments used in the calculations to account for altitude effects are not shown on the diagram in Fig. 1, as they are unrelated to the procedures.

A more detailed description of the procedures is contained in Table 2 and two examples of the resulting profiles are illustrated in Figs. 2 and 3. Fig. 2 gives the profiles for the DC 9-10 at a typical gross weight of 80,000 lbs for the six procedures initiated at an altitude of 305 meters. Fig. 3 gives similar information for the B707-320B at a maximum gross weight of 333,600 lbs.

TABLE 2. DESCRIPTION OF TAKEOFF PROCEDURES.

SEGMENT	PROCEDURES					
	1a) Cleanup before max. cutback	1b) Cleanup before max. cutback below & min. cutback above 914 meters	2) Cleanup before min. cutback	3a) Max. cutback	3b) Max. cutback below & min. cutback above 914 meters	4) Min. cutback before cleanup
1st Segment						
A. Takeoff Roll	From A_1 accelerate to takeoff velocity with takeoff thrust and flaps					
B. Initial Climb	From B_1 retract gear and climb at takeoff thrust and velocity to C_1 at an altitude of 122,305 or 610 meters					
2nd Segment						
C. Intermediate Climb	From C_1 accelerate 10 knots to C_2 @ C_2 retract ½ flap & accelerate to V_{NW}* @ C_3 @ C_3 retract flaps & initiate max. thrust cutback & climb to D_1 at an altitude of 914 meters		min. thrust cutback	@ C_1 initiate maximum cutback and climb at constant velocity to D_1, at an altitude of 914 meters		From C_1 accelerate 10 knots to C_2 @ C_2 retrack ½ flap, initiate min. thrust cutback & accelerate to V_{ZF}* @ C_3 @ C_3 retract flaps & climb at constant velocity to an altitude of 914 meters
3rd Segment						
D. Final Climb to 3048 meters	@ D_1 maintain climb at constant velocity	@ D_1 increas thrust to min. thrust cutback & climb at constant velocity	@ D_1 accelerate to 250 knots @ D_2 @ D_2 resume climb @ 250 knots	@ D_1 maintain climb at constant velocity	@ D_1 increase thrust to min.cutback thrust & accelerate 10 knots to D_2 @ D_2 retract ½ flap & accelerate to V_{ZF} at D_3 @ D_3 retract flaps & accelerate to 250 knots @ D_4 @ D_4 resume climb at 250 knots	@ D_1 accelerate to 250 knots @ D_2 @ D_2 resume climb at 250 knots

*V_{NW} is speed for best climb after flap retraction recommended in the Northwest Airlines procedure, and V_{ZF} is zero flap minimum safe maneuvering speed.

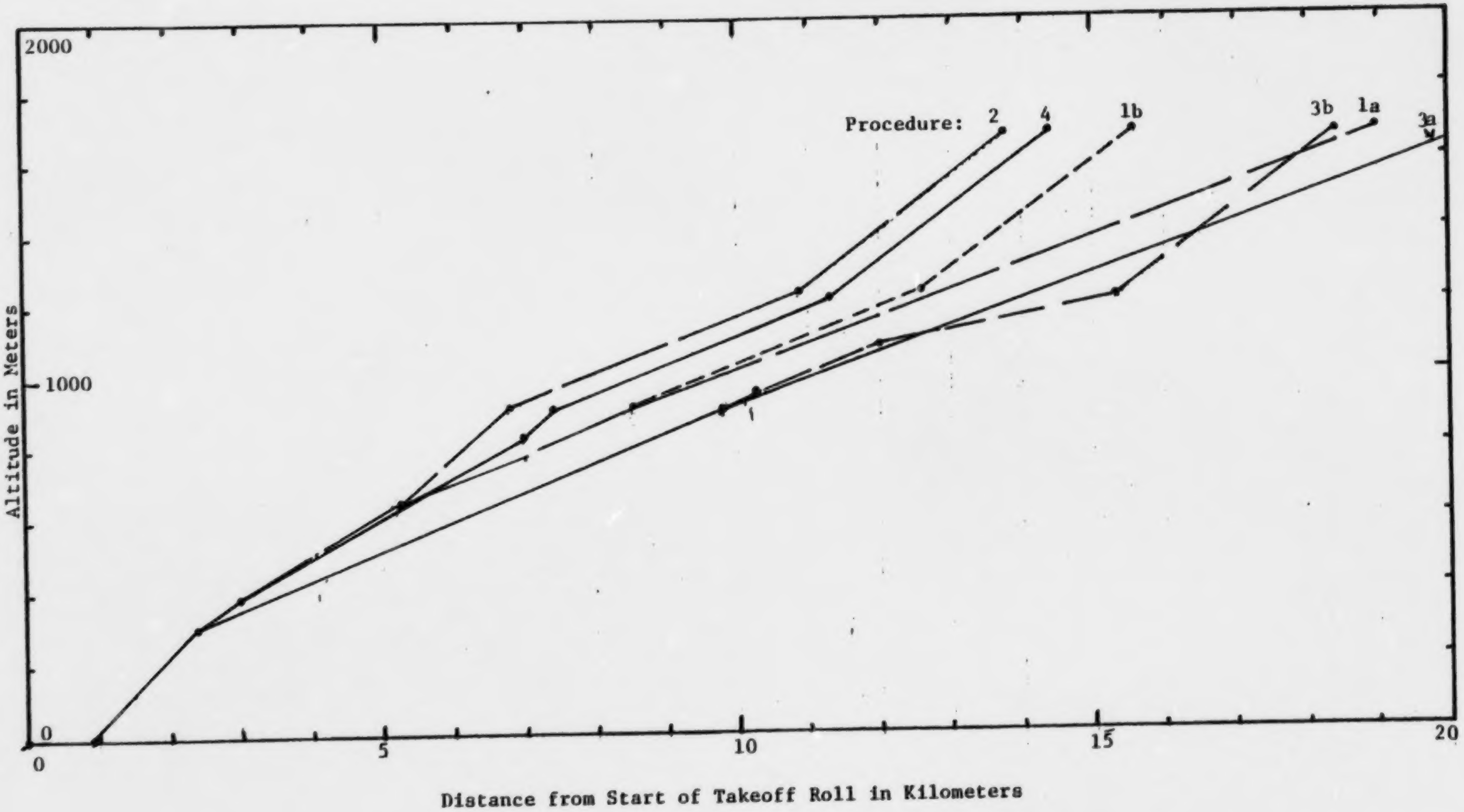

FIG. 2 PROFILES USED FOR THE DC9-10 AIRCRAFT AT 80,000 LBS TAKEOFF WEIGHT FOR ALL SIX PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS.

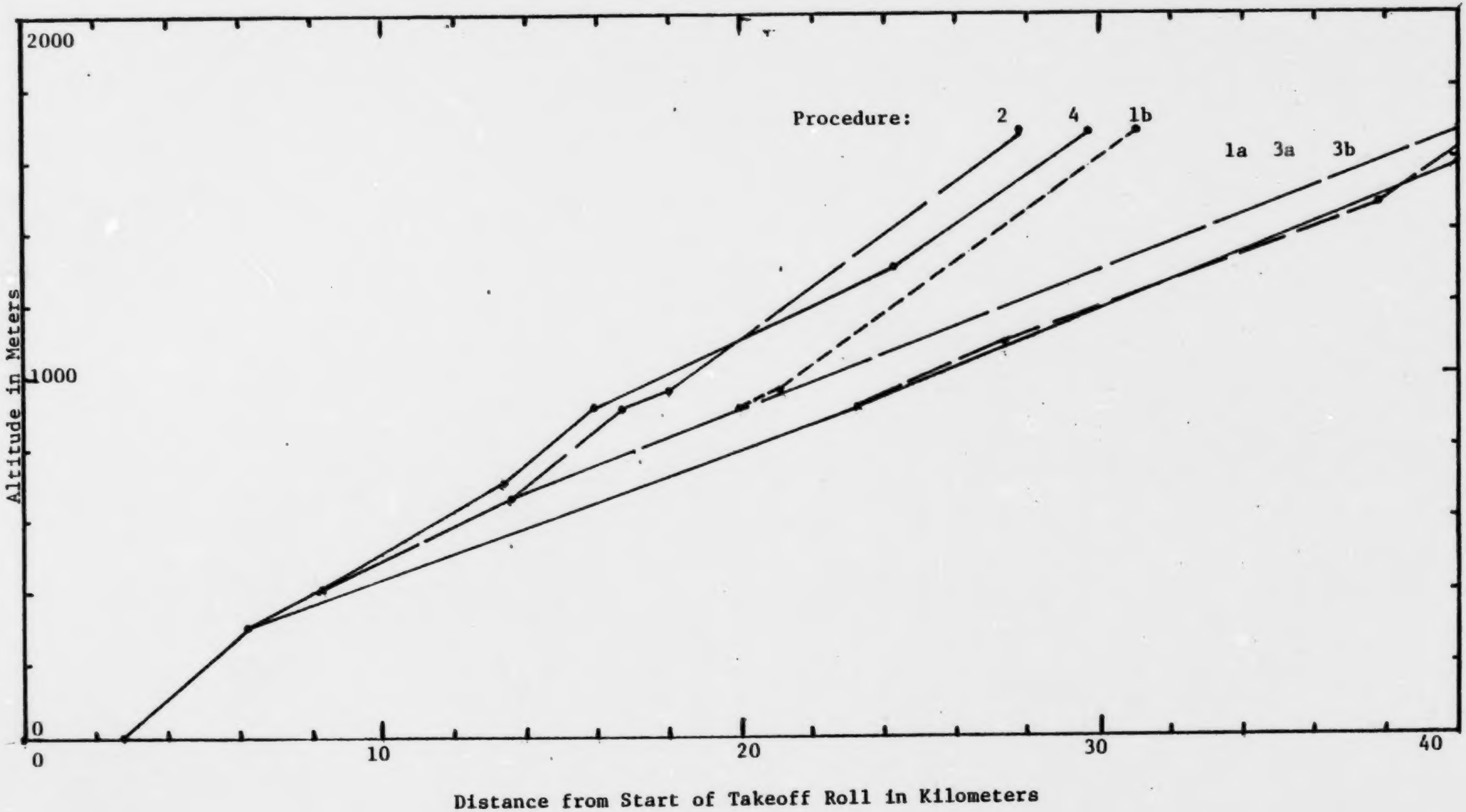

FIG. 3 PROFILES USED FOR THE B707-320B AIRCRAFT AT 333,600 LBS TAKEOFF WEIGHT FOR ALL SIX PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS.

Procedures 2 and 4 both have minimum thrust cutback (to climb power). However, in procedure 2 the aircraft flaps are retracted before thrust cutback, whereas in procedure 4 only a partial flap retraction is accomplished before thrust is cut back. Therefore, procedure 2 maintains takeoff thrust for a longer distance than does procedure 4, accelerates more rapidly and reaches the final climb segment at 250 knots in a shorter distance from start of takeoff roll.

Procedures 1a and 1b both cleanup before initiating maximum thrust cutback to the minimum thrust required for one-engine out condition under FAR Part 25. However, for procedure 1b the thrust is increased to minimum thrust cutback at an altitude of 914 meters, and the aircraft is accelerated to 250 knots. The constant speed final climb for procedure 1b begins at a greater distance from the start of takeoff roll than that of either procedures 2 or 4 because of the distance over which the aircraft has maximum thrust cutback. These three procedures, as previously noted are similar to the operating procedures used by airlines with the initiation of the final climb segment at various altitudes between 914 and 1219 meters, or delayed until the aircraft is beyond the populated regions. Procedure 1a represents such a delay in initiating a resumption of thrust increase, extending the thrust cutback to an altitude of 3048 meters.

Procedures 3a and 3b both have maximum thrust cutback, initiated prior to cleanup. The thrust is cut back to the minimum thrust allowed by FAR Part 36 certification. In procedure 3b, at an altitude of 914 meters, the thrust is increased to minimum thrust cutback, the aircraft is accelerated, flaps retracted, further accelerated to final climb at 250 knots. In procedure 3a the maximum thrust cutback is maintained without cleanup in a constant speed climb to 3048 meters.

The FAR Part 25 thrust cutback limitations require that the aircraft be able to maintain with one engine inoperative a positive climb gradient of 1.2, 1.5, or 1.7 percent for 2-, 3- or 4-engined aircraft, respectively. These requirements are more stringent than those of FAR Part 36 which limits thrust cutback to the thrust that would insure level flight with one engine inoperative or a 4 percent climb gradient with all engines operating, whichever requires greater thrust. Generally, under Part 36 the minimum thrust of 2- and 3-engined aircraft are limited by the engine out requirement and that of 4-engined aircraft by the 4 percent minimum gradient. For the aircraft and procedures in this study the actual value of the normalized thrust for maximum thrust cutback is less for procedures 1a and 1b than that for 3a and 3b, because for procedures 1a and 1b the aircraft is in a clean aerodynamic configuration when thrust is cut back, requiring less thrust to meet the climb gradient requirements of Part 25 than required by an aircraft with flaps extended for the requirements of Part 36.

During the acceleration subsegments, at either takeoff power for procedures 1a, 1b and 2 or at maximum climb power for procedures 3b and 4, there is a choice to be made between rate of climb and acceleration. Most operational procedures require maintaining a minimum rate of climb between 500 and 1000 feet/min. The NW/ALPA procedure requires a minimum rate of climb of 500 feet per minute, but the FAA AC91-53 has no specific requirement. For most of the profiles in this study approximately 1/3 of the excess thrust was applied to acceleration and 2/3 to climb except that where the acceleration subsegments become very long, the fraction of thrust applied to acceleration was increased.

Appendix B contains information on sixty of the profiles, five for each aircraft/weight combination. For each profile the information includes the altitude, distance from start of takeoff roll, velocity (Indicated Air Speed) and normalized thrust for the initiation of acceleration, cutback and end of acceleration (if different from cutback); and distances of takeoff roll and to an altitude of 1676 meters (5500 feet). The procedures included in Appendix B are:

- cleanup before maximum cutback, beginning at 122 meters (1a)
- cleanup before maximum cutback, beginning at 305 meters (1a)
- cleanup before minimum cutback, beginning at 305 meters (1b)
- maximum cutback before cleanup beginning at 305 meters (3a)
- minimum cutback before cleanup beginning at 305 meters (4).

3.3 Development of Noise Contour Data

The noise contour data for the 216 cases were generated using the Noisemap computer model [12, 16]. The data were calculated for a straight flight track extension of a single runway airport configuration, illustrated in Figure 4. The calculations extend for a distance of 42.7 km (26.5 statute miles) from start of takeoff roll. The grid size of 450 meters was chosen such that the 450 meter sideline data would be calculated directly, and the zero location was chosen so that the level at the 6500 meter FAR Part 36 takeoff measurement position would be similarly calculated directly. Takeoff noise data reported in Appendix A include both of these locations and three other locations on grid points under the flight path at distances from start of takeoff roll of 4700, 9200, and 12800 meters.

The FAR Part 36 takeoff measurement position is 6500 meters (approximately 3.5 nautical miles) from start of takeoff roll. This measurement position has proved practical for measuring noise from large aircraft, but appears further than ideal from the point of view of desirable measurement signal-to-noise ratio for smaller quiet business jets. For these, Galloway [17] has suggested the use of a location at 2.5 nautical miles which is approximately their average balanced field length (1536 meters) plus 3000 meters. This 2.5 nautical mile location is rounded up in metric units to 4700 meters from start of takeoff roll so that it occurs on a grid point for this study.

If it were desirable to specify lapse rate beyond the primary measurement location an additional location is required. For this study two additional locations, 9200 and 12800 meters from start of takeoff roll, each representing approximately twice the distance of one of the primary locations, have been examined. Table 3 summarizes the four locations used in this study. They closely approximate 2.5, 3.5, 5 and 7 nautical miles and their ratios nearly form part of a geometric series based on the square root of 2.

TABLE 3. LOCATIONS OF TAKEOFF NOISE MEASUREMENT DATA REPORTED IN APPENDIX A.

	Distance from Start of Takeoff Roll			Ratio of
Pos	Meters	Nautical Miles	(Rounded)	Distance
1	4700	2.54	(2.5)	1
2*	6500	3.51	(3.5)	1.38
3	9200	4.96	(5.0)	1.96
4	12800	6.91	(7.0)	2.72

*Standard FAR Part 36 measurement location.

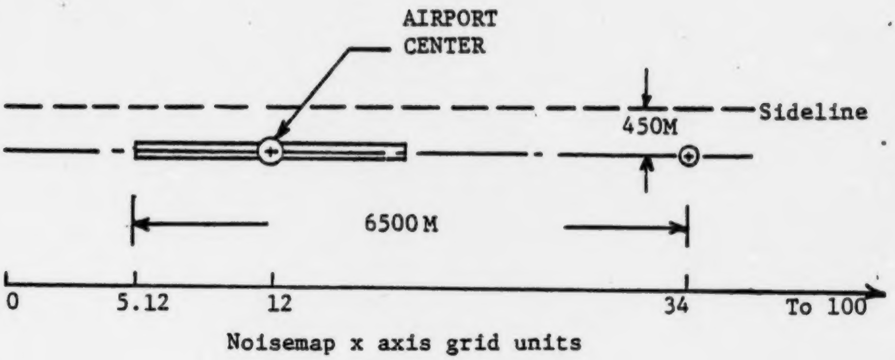

FIG. 4 SINGLE RUNWAY MODEL WITH GRID INCREMENTS AT 450 METERS AND ESTABLISHED SUCH THAT 450M SIDELINE IS A GRID LINE AND THE 6500M TAKEOFF LOCATION IS A GRID POINT.

The noise data used for the computation are a modified version of the standard Noisemap civil fleet data base. [13] This data base contains values of EPNL as a function of slant distance at intervals of one-tenth decade of distance for selected thrusts. The values at 305 meters (1000 feet) are the reference values based on evaluation of measured data. EPNL values are given for both air-to-ground and ground-to-ground propagation. The ground-to-ground propagation is applied by the noise map program for elevation angles of the aircraft from the observer of 0 to 4.18° with a transition to air-to-ground propagation between 4.18° and 7.18°.

The data base of reference 13 was modified by replacing its duration correction of $10 \log \frac{S.D.^{*}}{305}$ by a correction based on $6 \log \frac{S.D.}{305}$. This revised formulation for duration is based on recent analyses of aircraft noise data by SAE subcommittees, USAF, FAA, and others, and is being incorporated in the revised noise data base for the FAA Integrated Noise Model [18]. Because of this modification the noise data used in this study are lower than those of reference 13, at slant distances greater than 305 meters, the difference being 4 dB at a slant distance of 3048 meters.

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*S.D. is slant distance in meters.

Figure 5 summarizes the EPNL vs slant distance data used in this study for takeoff thrust for the 6 aircraft. Selected EPNL values for each aircraft are tabulated in Appendix B.

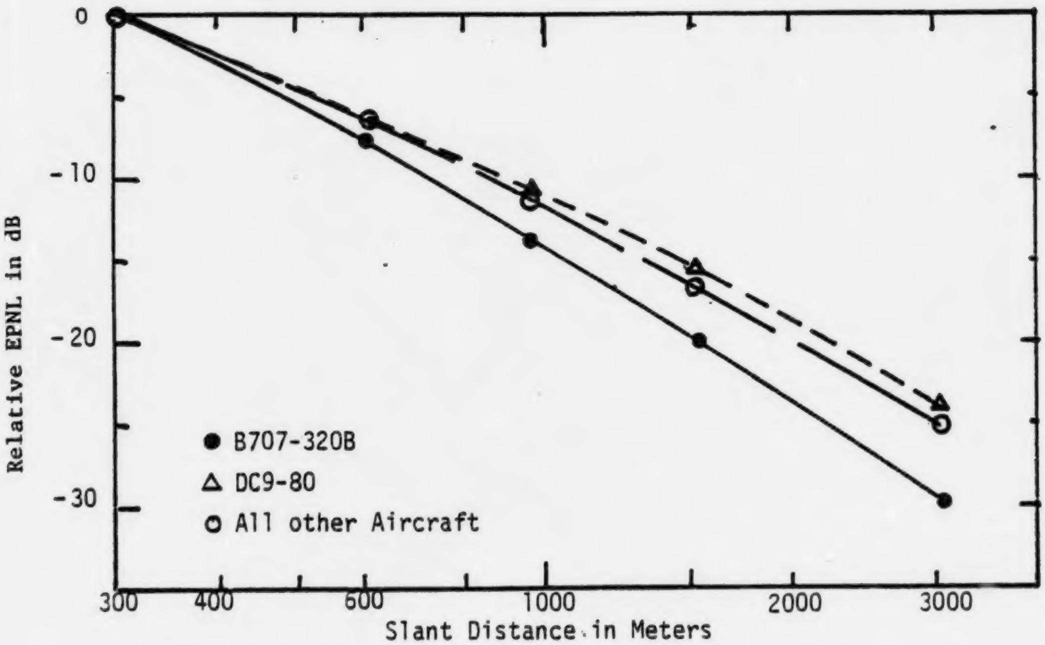

FIG. 5 VARIATION OF EPNL WITH SLANT DISTANCE FOR ALL 6 AIRCRAFT AT TAKEOFF THRUST.

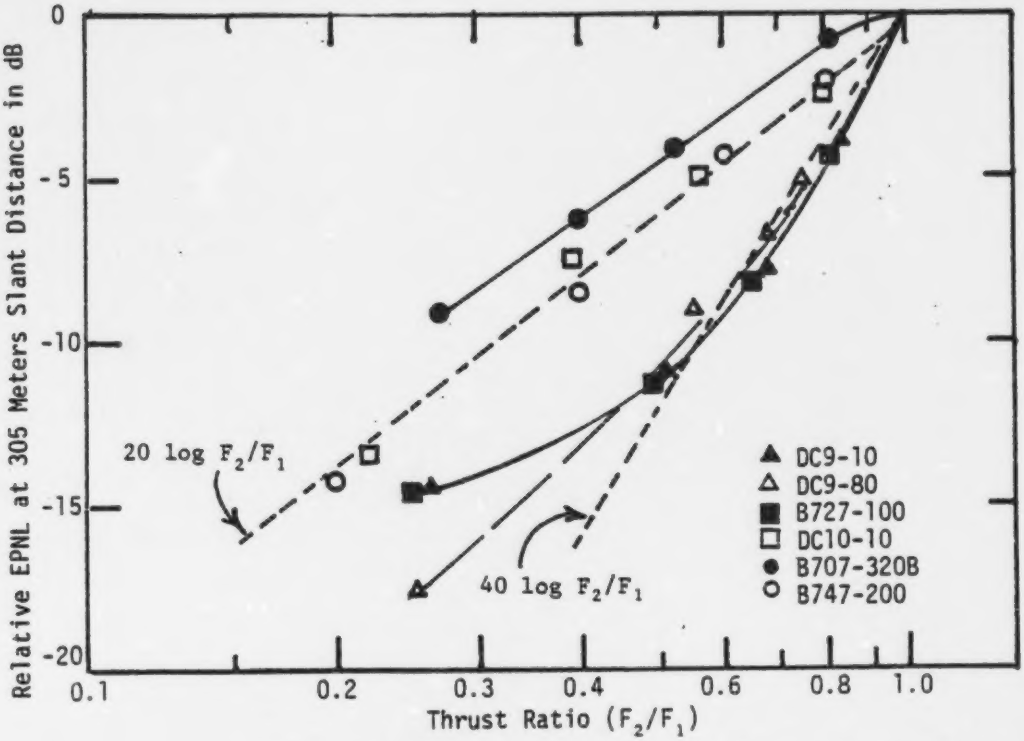

FIG. 6 VARIATION OF EPNL AT A SLANT DISTANCE OF 305 METERS WITH ENGINE THRUST RATIO. (Note variation may differ at other distances.)

Figure 6 shows the variation of EPNL at 305 meters slant distance as a function of the ratio of thrust to takeoff thrust. The variations may differ at other slant distances because of the varying spectral characteristics of the noise among engine types.

For each case, the program computed the values of EPNL above approximately 80 dB at each grid point. From these grid values the program computed the total area and several populations within each contour from EPNL values of 85 to 115 dB at intervals of 5 dB. The program output also included the total grid data and approximate contours of equal EPNL for each case, enabling determination of the distance to closure of each contour.

3.4 Estimation of Population Impact

The purpose of aircraft noise control certification and aircraft noise control operating procedures is to minimize the impact of noise on people. Because the spatial distribution of population is nonuniform with respect to any airport runway or flight track, analysis of the relative changes of impact with noise control need to consider population distribution, not just area, as a function of noise.

This study has made use of the FAA environmental data base [19] which includes for 500 airports the population data from the 1970 census within each one-mile wide annular ring to a radius of ten statute miles from the center of the airport. The data for 307 of these airports and their populations have been subdivided into three population density categories: X, Y, and Z. The selection of the 307 airports is taken from Reference 2 in which the airports were chosen to include all airports with more than 20 jet air carrier operations per year in 1975. The categories were also based on the analyses of these airports contained in references 2 and 3.

Category X consists of two airports (C-1 of Ref. 2), LaGuardia and Washington National, both of which have more than 100 operations per day of 2- and 3-engined aircraft, only and a high average population density. Category Y consists of 54 airports (A, B-1 and B-2 of Ref. 3) which have more than 100 operations per day of all aircraft types and have intermediate population density. Category Z contains 251 airports (B-3 and C-2 of Ref. 3) which have less than 100 operations daily and have a lower population density. 72 of the airports in Category Z have all types of aircraft, whereas the remainder are limited to 2- and 3-engined aircraft.

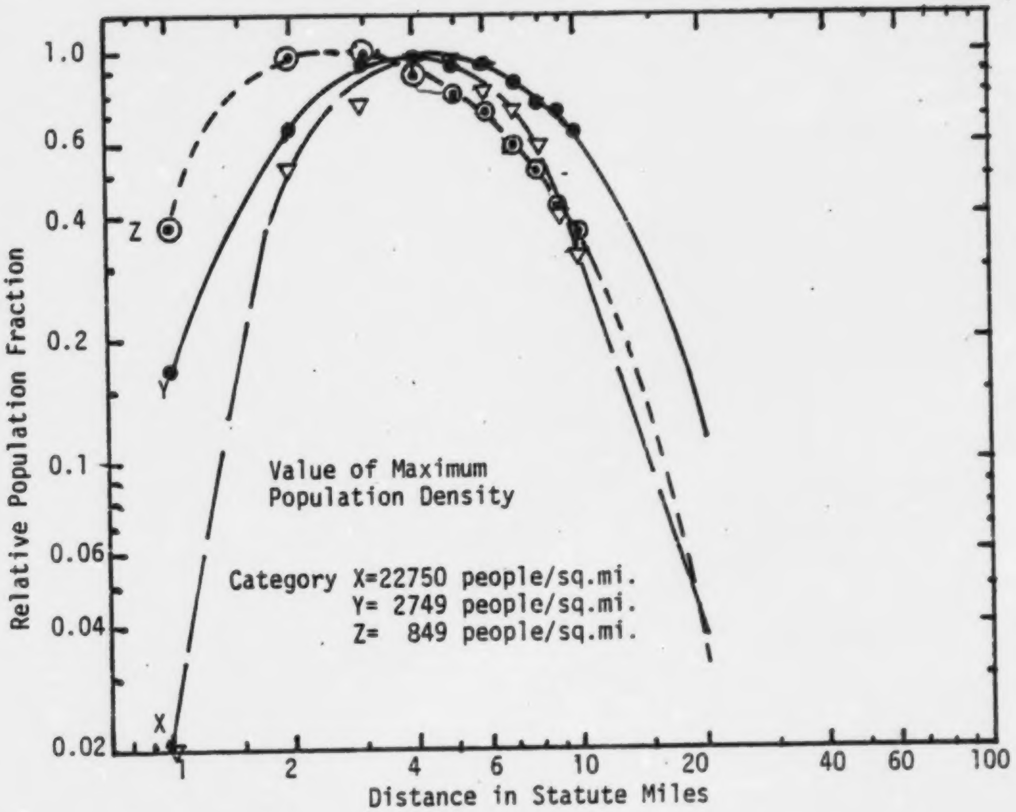

FIG. 7 RELATIVE POPULATION DENSITY DISTANCE FUNCTIONS USED FOR THE THREE POPULATION DENSITY CATEGORIES.

Figure 7 summarizes the population distance functions for the three categories. The data represent the average population density for each category. The average population density was computed by calculating the total population in each category for each ring from the data base [19], and dividing by the ring area and the number of airports. The data are extrapolated beyond 16.1 km (10 statute miles). These functions were used in a Noisemap subroutine to assign population denisty values at the grid points and to sum for each category of population density (X, Y, and Z) the population included within each contour from EPNL values 85 to 115 dB, at 5 dB intervals. These data are summarized for each case in Appendix A.

Figure 8 illustrates the general relationships between total contour area and population for each of the three categories. The data were taken from procedures 1a and 3a for all aircraft weights, using the 2-, 3- and 4-engined aircraft for category Y and 2- and 3-engined aircraft for categories X and Z. The general relationship between population and total contour area for categories Y and Z are consistent with relationships developed from full airport contours [2] when the population densities are adjusted to be comparable. The results for category X, which contains only two airports with significantly different population densities, are not directly comparable with the average results for total airport contour area in Ref. 2, because of the different weightings given to these two airports in the total airport contours method [20] and the current single runway contour method.

For analysis it is desirable to combine the results for the three population density categories to obtain an approximate value of the total national population which is at least occasionally exposed to various EPNL values resulting from the takeoff of a single aircraft. Further, it is also desirable for analysis to attempt to estimate for each case a single value which is related to the potential national noise impact for each aircraft/weight/procedure combination. For these purposes two types of weighted populations were calculated from the detailed population results in the three categories. They are:

- *Airport/runway* weighted population
- *Airport/runway level* weighted population.

Both of these estimates are necessarily crude; however, their *relative* values with respect to both aircraft, weight and procedures are considered meaningful for comparative analyses.

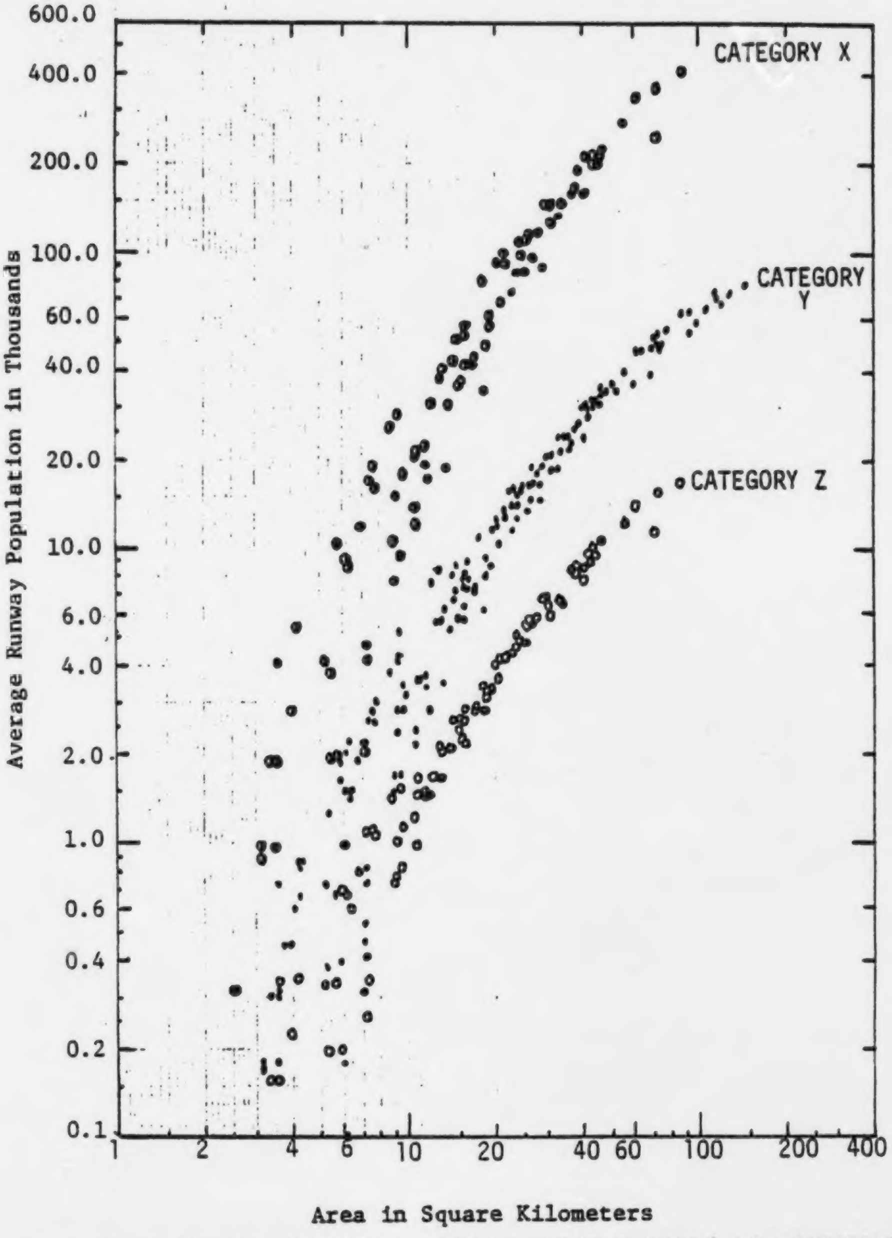

FIG. 8 AVERAGE RUNWAY POPULATION (SINGLE EVENT CONTOUR) FOR PROCEDURES 1a, 3a AND 4 USING ALL 2- AND 3-ENGINED AIRCRAFT WEIGHT COMBINATIONS FOR CATEGORIES X AND Z AND ALL 12 AIRCRAFT WEIGHT COMBINATIONS FOR CATEGORY Y.

The *airport/runway* weighted population is an estimate of the total number of people residing in areas where the EPNL is estimated to exceed a stated value. It is derived by multiplying the populations for a specific aircraft procedure in each population density category within a specified single event contour by the number of airports in the population density category and by the number of active runway ends estimated for a typical airport of the category, and then summing the results. The 2- and 3-engined aircraft are assumed to be heard near airports in all three population density categories; the 4-engined aircraft only near airports in category Y, thus ignoring, for simplicity, the 4-engined aircraft operating at 72 of the 251 airports in category Z. If these 72 airports had been included the airport/runway weighted population for the two aircraft with 4 engines would be increased about 17%. The appropriate multipliers are summarized in Table 4.

TABLE 4. MULTIPLIERS USED FOR ESTIMATING AIRPORT/RUNWAY WEIGHTED POPULATION FROM SINGLE EVENT CONTOUR POPULATION.

Population Density Category	Multipliers for 2- & 3-engined aircraft	Multipliers for 4-engined aircraft
X (2 airports with 4 runway ends)	8	0
Y (54 airports with 4 runway ends)	216	216
Z (251 airports with 2 runway ends)	502	0

The *airport/runway level* weighted population is an estimate of the total level weighted population for a given aircraft procedure, *assuming that the fleet consists only of the given aircraft.* The level weighted functions [21] are based on the Day/Night Sound Level (L_{dn}), a cumulative noise descriptor, not the EPNL, a single event noise descriptor. To obtain an approximate relationship between L_{dn} and EPNL for this purpose, the EPNL associated with L_{dn} 65 (Noise Exposure Forecast (NEF) of 30) was calculated for each population density category. The calculation utilized the average daily operations for each airport category [2,3] divided by the number of runway ends assumed for a typical airport in the category, as shown in Table 5.

TABLE 5 APPROXIMATE VALUE OF EPNL FOR L_{dn} OF 65 dB (NEF 30) FOR THREE POPULATION DENSITY CATEGORIES.

Population Density Category	Number of Airports	Typical Number Runway Ends	Average Effective Operations 1975	Approximate Value of EPNL for NEF 30
X	2	4	635	96.0
Y	54	4	569*	96.5
Z	251	2	18	108

***Used 10% nighttime operations.**

In order to check the reasonableness of this approach, the total populations estimated for 1975 operations were compared by category with previous results [3] which were based on a series of 4 average airports with appropriate fleet mixes, flight paths, weights, etc. The comparison was made using data for the B727-100 aircraft because its EPNL at 1000 feet is essentially equal (0.2 dB less) to the 1975 fleet average EPNL, where the averaging is based on energy considering both the noise and annual number of operations by aircraft type [22]. The calculations were based on procedure 4, with initiation of cutback at an altitude of 457 meters (1500 feet), which is similar to the ATA procedure. They were made for both the 10 and 6 log distance duration functions.

For the data calculated with a 10 log duration distance correction [13], the total population estimated from the single event approach is 5006 thousand people as compared with 4884 thousand people from the previous estimate [3] (see Table 6). The fact that these two methods agree within 2% is probably fortuitous, but it suggests that the methodology may be reasonable for the evaluation of the sensitivity of relative impacts to the aircraft/procedure variables. However, the population values themselves must be expected to be *less accurate* than those of the previous studies that were designed to determine such values and that properly accounted for the actual flight track locations with respect to the spatial distribution of population, and the actual mix of aircraft operations and weights for each airport category.

The results in Table 6 also show that the population estimated to reside in areas where the L_{dn} exceeds 65 is reduced by approximately 40% for categories X and Y when the data calculated with the revised noise function are compared with those calculated with the standard noise function. This percentage reduction in population is approximately equivalent to a 2.0 to 2.5 dB reduction of the noise of the 727 aircraft at EPNL values of 96 dB. No change is seen in category Z which represents people residing close to the airport.

TABLE 6. NATIONAL POPULATION (1000s) ESTIMATED TO RESIDE WITHIN NEF 30 FROM PREVIOUS STUDY COMPARED WITH THIS APPROXIMATE MODEL USING B727-100 AIRCRAFT, MAX GROSS WEIGHT, APPROXIMATE ATA PROCEDURES, BOTH STANDARD AND REVISED NOISE LEVEL DISTANCE FUNCTIONS, 1970 CENSUS AND 1975 OPERATIONS.

POPULATION CATEGOTY	ESTIMATED FROM AVEPORT MODELS [3]	Estimated from 727-100 Single Event Data			
		Standard Noise Function [3]		Revised Noise Function*	
		Per Runway End	All Airports	Per Runway End	All Airports
X	1118	140.80	1126	84.00	672
Y	3530	17.10	3694	10.30	2225
Z	236	0.37	186	0.37	186
Totals	4884	--	5006	--	3083

*Revised noise function has 6 log $\frac{S.D.}{305}$ duration correction.

Table 7 summarizes the estimates of average L_{dn} for each population category and EPNL interval, and gives the associated level weighting function [21]. The *airport/runway level* weightings are derived by multiplying the level weighting functions by the *airport/runway* weighting multipliers in Table 5. When these weightings are applied to the population data of any specific aircraft the strict implication is that the specific aircraft is the only aircraft type in the fleet and that it accounts for all of the operations in the fleet. When this technique is applied to the B727-100 aircraft, the population data were previously shown to be similar to those derived from actual fleet mixes. This similarity is meaningful only because the noise of the B727-100 is approximately equal to that of the fleet average aircraft. Such similarity is neither expected nor meaningful when the specific aircraft's noise differs from the fleet average noise. Thus, the comparison in this study of the *airport/runway level* weighted populations amongst

TABLE 7 WEIGHTINGS FOR LEVEL WEIGHTED POPULATION AND FOR AIRPORT/RUNWAY LEVEL WEIGHTED POPULATION USED FOR ANALYZING RELATIVE IMPACT.

EPNL INTERVAL	AVERAGE L_{dn} FOR POPULATION CATEGORY			WEIGHTING FUNCTION [20] FOR AVERAGE L_{dn}			AIRPORT/RUNWAY LEVEL WEIGHTINGS		
	X	Y	Z	X	Y	Z	X*	Y	Z*
85-90	56.5	56.0	44.5	.152	.142	.027	1.22	30.67	13.55
90-95	61.5	61.0	49.5	.281	.265	.051	2.25	57.24	28.61
95-100	66.5	66.0	54.5	.479	.456	.116	3.83	98.50	58.23
100-105	71.5	71.0	59.5	.756	.725	.221	6.05	156.60	110.94
105-110	76.5	76.0	64.5	1.118	1.078	.391	8.94	232.85	196.28
110-115	81.5	81	69.5	1.577	1.526	.636	12.62	329.62	319.27

*Used only for 2- and 3-engined aircraft.

aircraft types represents a comparison of relative *potential airport/runway level* weighted population assuming that the fleet consists of only that type aircraft and that the total number of fleet operations is identical for all aircraft. With this understanding such comparisons can be useful on a relative basis to analyze the relative potential noise impacts of alternative procedures and the effects of aircraft/engine/weight combinations.

4. ANALYSIS OF RESULTS

This section contains an analysis of selected results from the data presented in Appendix A. It begins with a detailed analysis of procedure 3a, maximum cutback before cleanup to examine the interrelationships among some of the data and to provide a baseline for analysis of differences among procedures. It continues by examining the effect of the resumption of climb thrust (minimum thrust cutback), after maximum cutback, procedures 1b and 3b, followed by comparisons amongst the four basic procedures: 1a, 2, 3a, and 4. It concludes with a discussion of the implications of these results with respect to the development and analysis of possible future goals for aircraft noise.

4.1 Procedure 3a, Maximum Cutback Before Cleanup

Procedure 3a is the simplist procedure considered in this study, consisting only of a maximum cutback at the initiation of the second segment with no acceleration or cleanup below an altitude of 3048 meters. As previously noted, it is based on the FAR Part 36 flight procedures which allow slightly greater thrust cutback than is allowed in actual operation under FAR Part 25. Additionally, because in this study the procedure is initiated at each of three specific altitudes, the profiles do not coincide with the profile used for certification by any specific aircraft. For certification the cutback initiation altitude is selected to be as high as possible prior to the 6500 meter takeoff measurement point so that the measured EPNL will be minimum.

Figure 9 shows the EPNL calculated at 4 points under the takeoff path for the six aircraft at maximum gross weight, with cutback initiated at 305 meters. With the exception of the B747-200, all aircraft have reached an altitude of 305 meters before reaching the 6500 meter location. At the lighter typical weight,

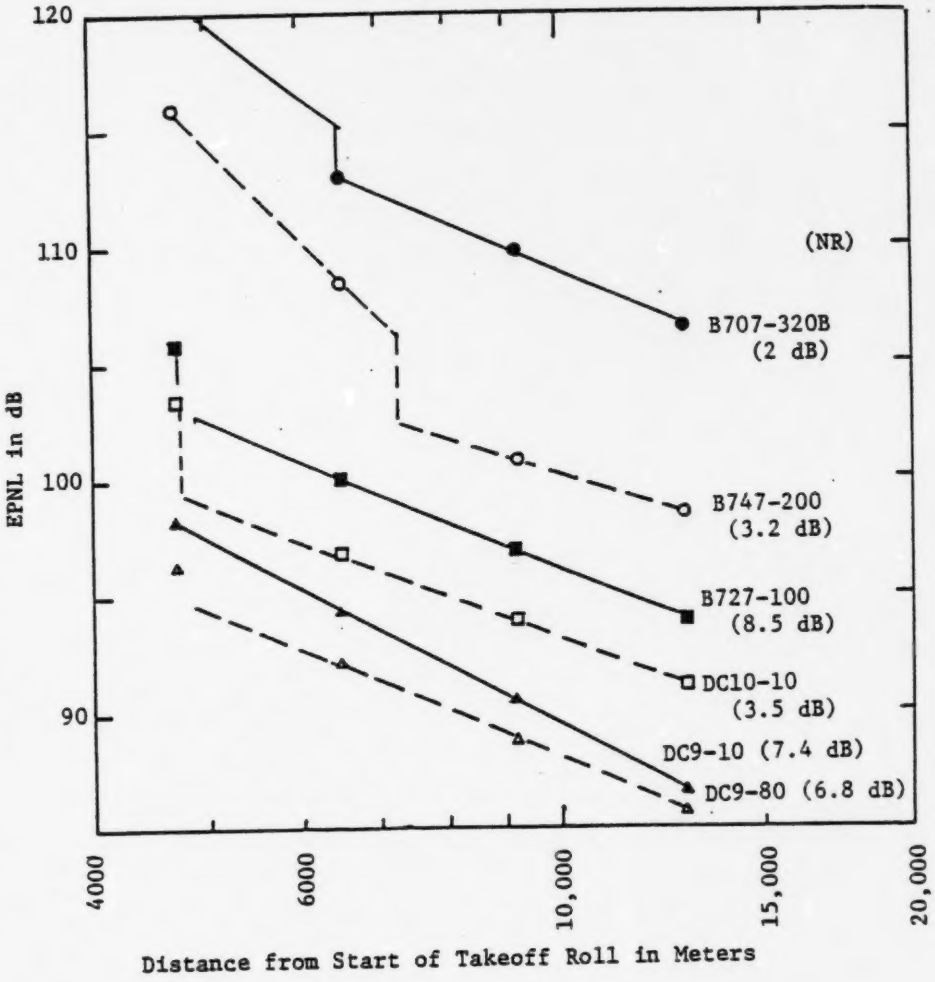

FIG. 9 EPNL COMPUTED AT 4 LOCATIONS DIRECTLY BELOW THE FLIGHT PATH FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR 6 AIRCRAFT AT MAXIMUM GROSS WEIGHT WITH APPROXIMATE NOISE REDUCTIONS DUE TO THRUST CUTBACK IN ( ).

all aircraft have reached an altitude of 305 meters before reaching 6500 meters from start of takeoff roll. The approximate noise reductions at a standard slant distance of 305 meters resulting from thrust cutback at maximum gross weight, indicated on the figure, range from 2 dB for the B707-320B to 7.4 and 8.5 dB for the JT8D powered DC9-10 and B727-100 with intermediate values for the three aircraft that have high bypass engines. Note that the apparent noise reductions which may be deduced from this figure may differ slightly from that computed for thrust reduction at 1000 feet because of differences in altitude, velocity and the contribution of noise energy from the pre-cutback segment to the computed measurement.

Figure 10 illustrates the variation in area within each of the 85, 90 and 95 EPNL contours for the six aircraft at both weights as a function of the EPNL at 6500 meters. The B747-200 at maximum gross weight is shown for both the computed EPNL value and for its computed value less the 3.2 dB reduction which occurs just beyond the 6500 meter location.

Figure 11 presents the area data for the six EPNL levels from 85 to 110 dB, inclusive, normalized to the EPNL computed for the 6500 meter location. It includes all six aircraft at two weights each, except for the B747-200 at maximum gross weight, which is not included because its cutback has not occurred at the 6500 meter location. If it were included with a 3.2 dB reduction it would fit with the majority of the data. The data for four of the airplanes appear to collapse on one curve; that for the DC10-10 deviating from the curve in the region of 3 to 10 km; and that of the B707-320B forming its own curve for all areas. It is believed that the reason for the individual behavior of the B707-320B is that its EPNL vs slant distance function, shown in Fig. 5, is significantly different from that of the other five aircraft.

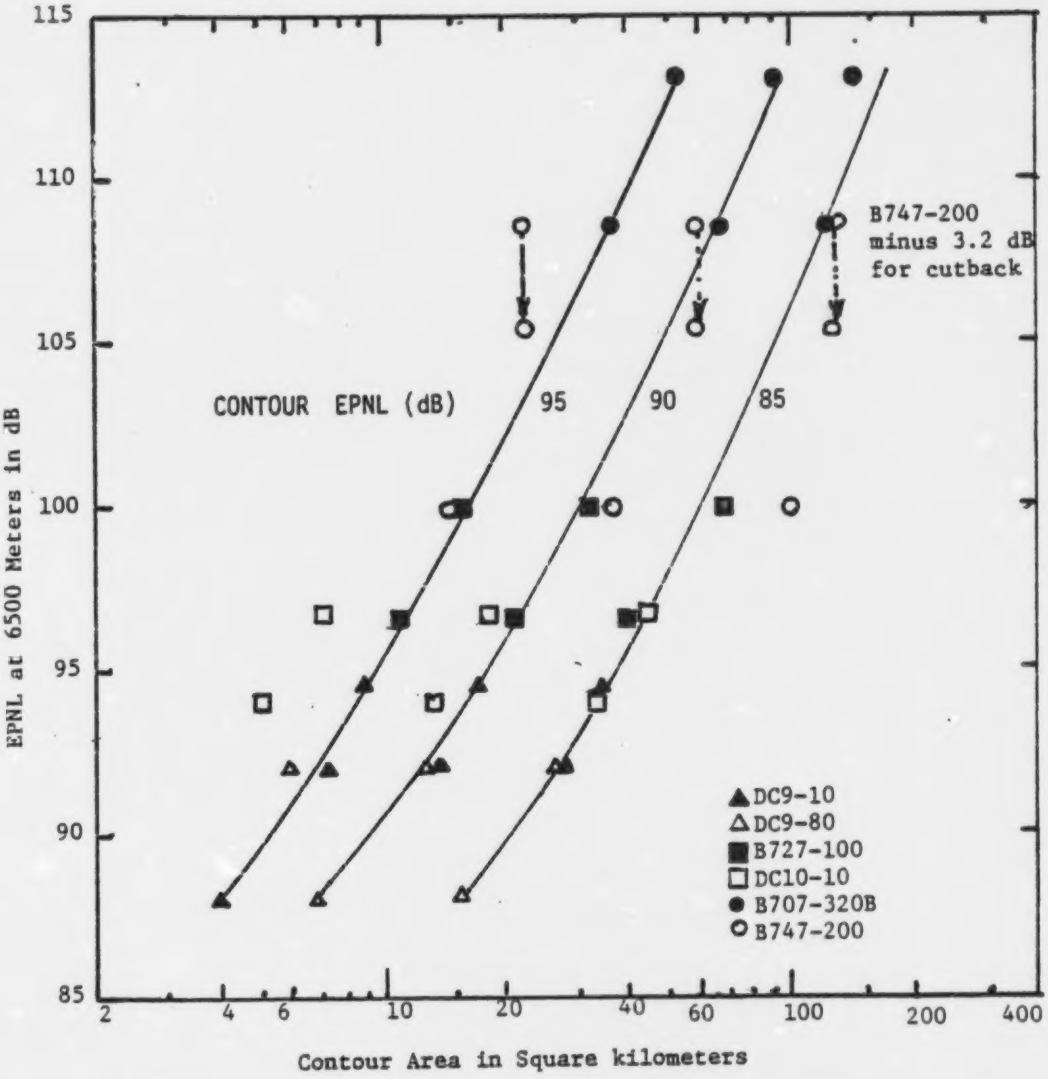

FIG. 10 VARIATION OF CONTOUR AREA WITH EPNL AT THE 6500 METER MEASUREMENT LOCATION FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS.

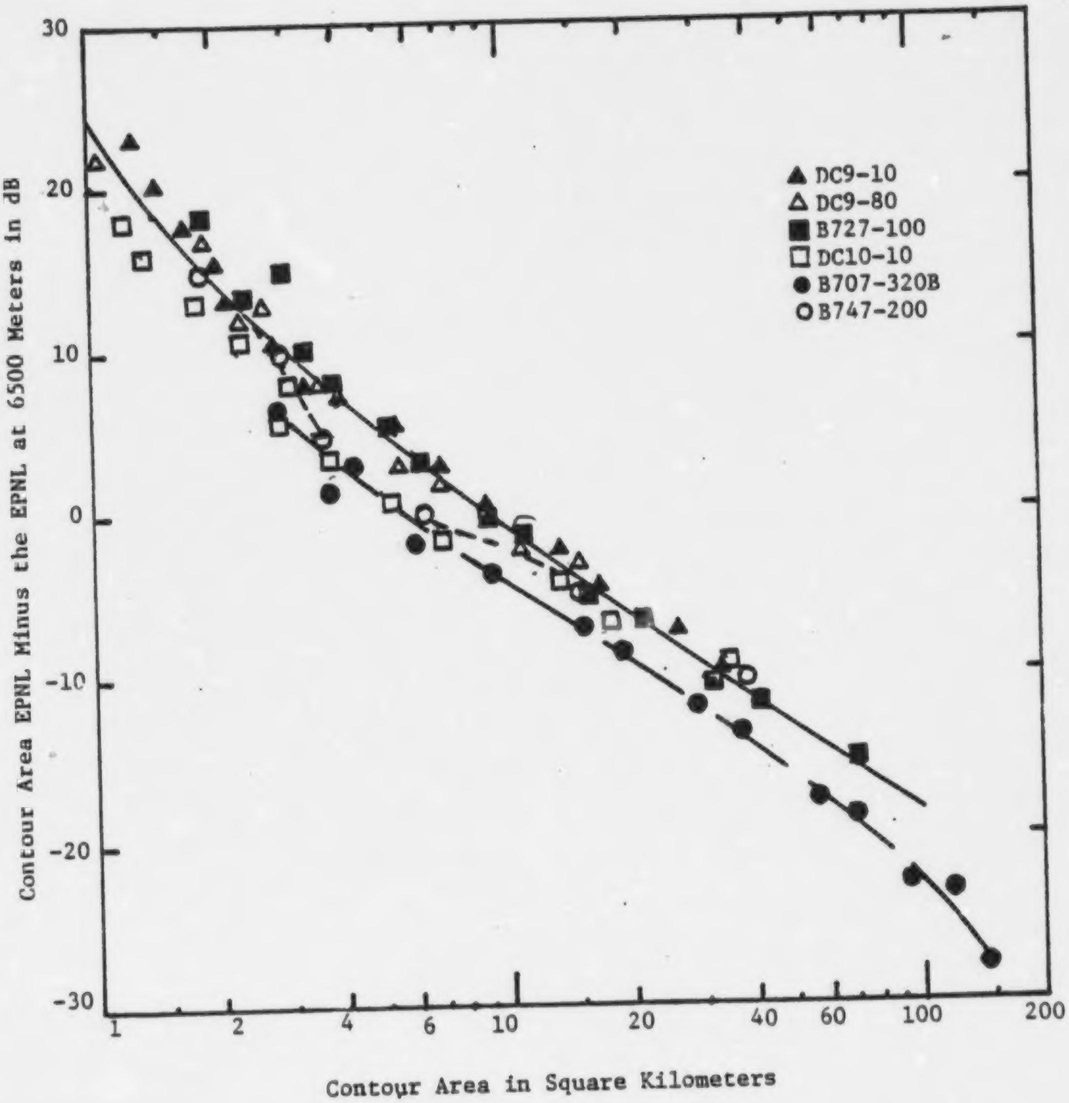

FIG. 11 VARIATION OF CONTOUR AREA WITH THE CONTOUR EPNL MINUS THE EPNL AT 6500 METERS FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS.

Figure 12 illustrates these same contour area data as a function of their associated contour level normalized to the value of EPNL at 305 meters for maximum cutback thrust. The correlation of these data does not appear as good as that obtained on Fig.11 where the actual computed EPNL at 6500 meters was used for the normalization. However, these data can be used as an approximate predictor of area vs EPNL for procedure 3a, only requiring as input the value of EPNL at 305 meters slant distance for maximum cutback thrust. A similar single value of EPNL at 305 meters for maximum climb thrust has been found to correlate well with aveport area data when procedures similar to procedure 4 were used. [3, 22]

Figure 13 illustrates the number of people estimated to hear each aircraft at both weights and at EPNL values greater or equal to 85, 90, and 95 dB. These population estimates are derived from the *airport/runway* weighted population in which the 2- and 3-engined aircraft were assumed to be heard at the airports in all three airport population density categories, X, Y, and Z, whereas 4-engined aircraft were assumed to be heard only at the 54 airports in category Y.

Figure 14 presents the *airport/runway level* weighted population for the same data. There appear to be useful trend curves through these population related data in both Figs. 13 and 14, for all aircraft and weights, despite the discontinuity in the population data base between the 2- and 3-engined aircraft and the 4-engined aircraft.

The general regularity of these various functions of area, *airport/runway* population and *airport/runway level* weighted population suggest that these correlations should be expected to be valid for procedure 3a (305 meters) for other aircraft. Further,

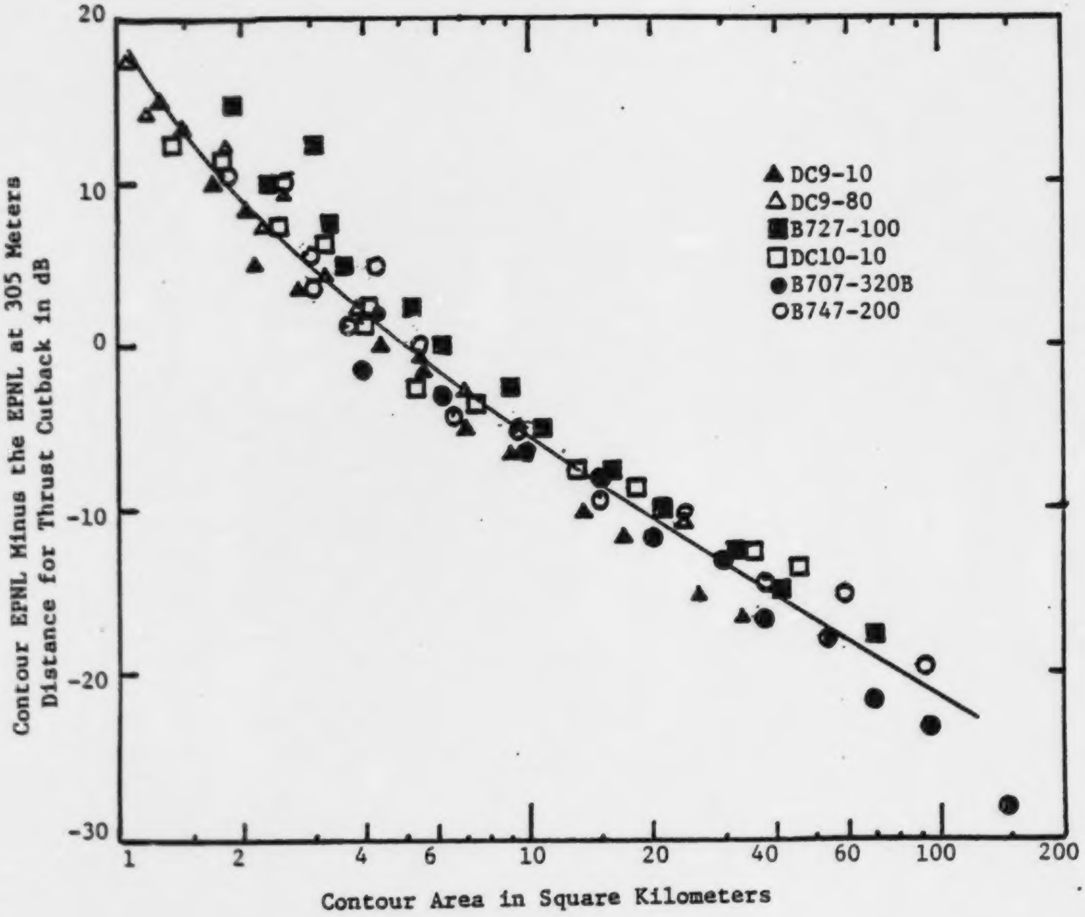

FIG. 12 VARIATION OF CONTOUR AREA WITH THE CONTOUR EPNL MINUS THE EPNL AT DISTANCE OF 305 METERS FOR THRUST CUTBACK FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS.

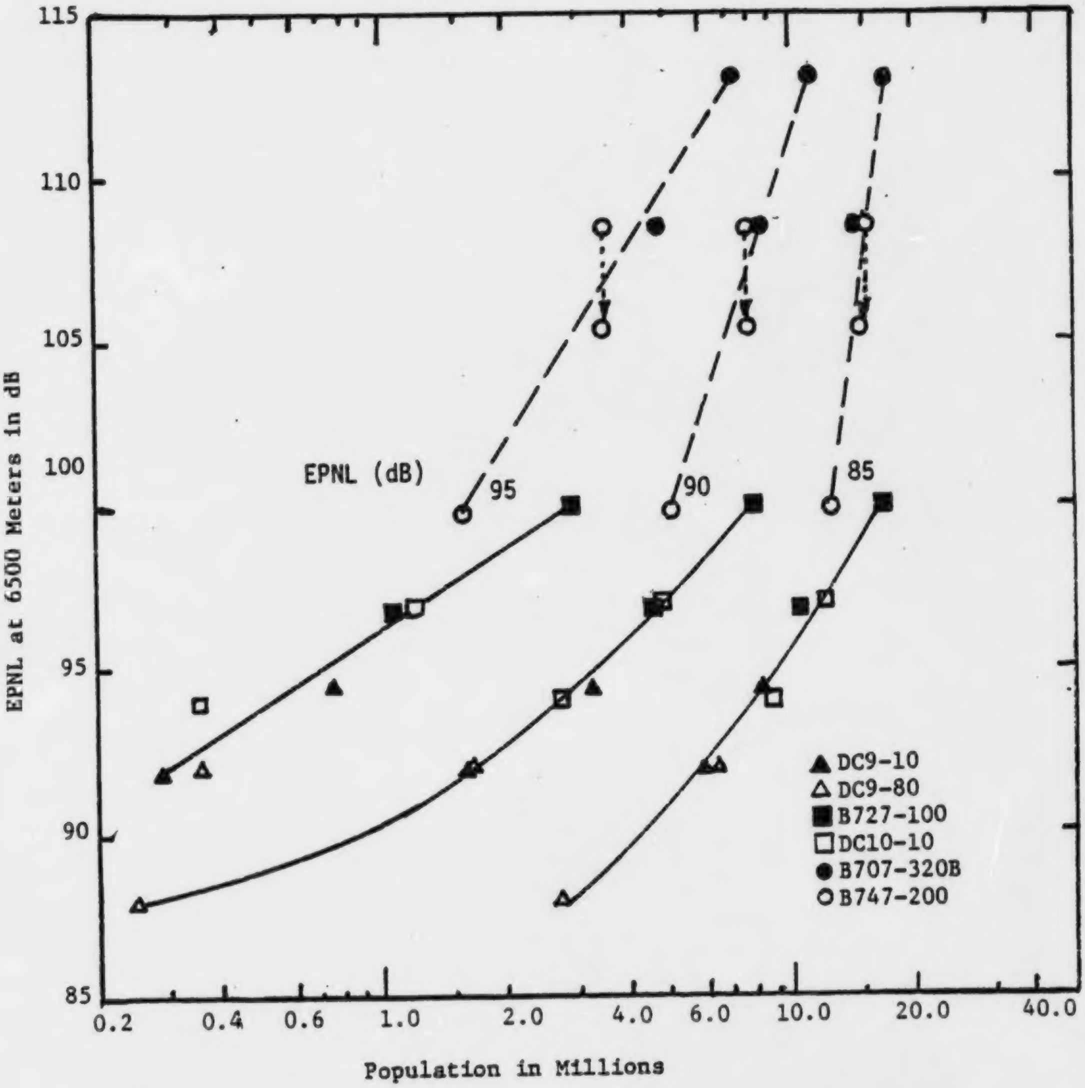

FIG. 13 VARIATION OF ESTIMATED *AIRPORT/RUNWAY* WEIGHTED POPULATION WITH EPNL AT THE 6500 METER MEASUREMENT LOCATION FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS. NOTE THAT THE POPULATION FOR 4-ENGINED AIRCRAFT IS BASED ONLY ON THE Y POPULATION CATEGORY, WHILE THAT FOR 2- AND 3-ENGINED AIRCRAFT IS BASED ON ALL CATEGORIES.

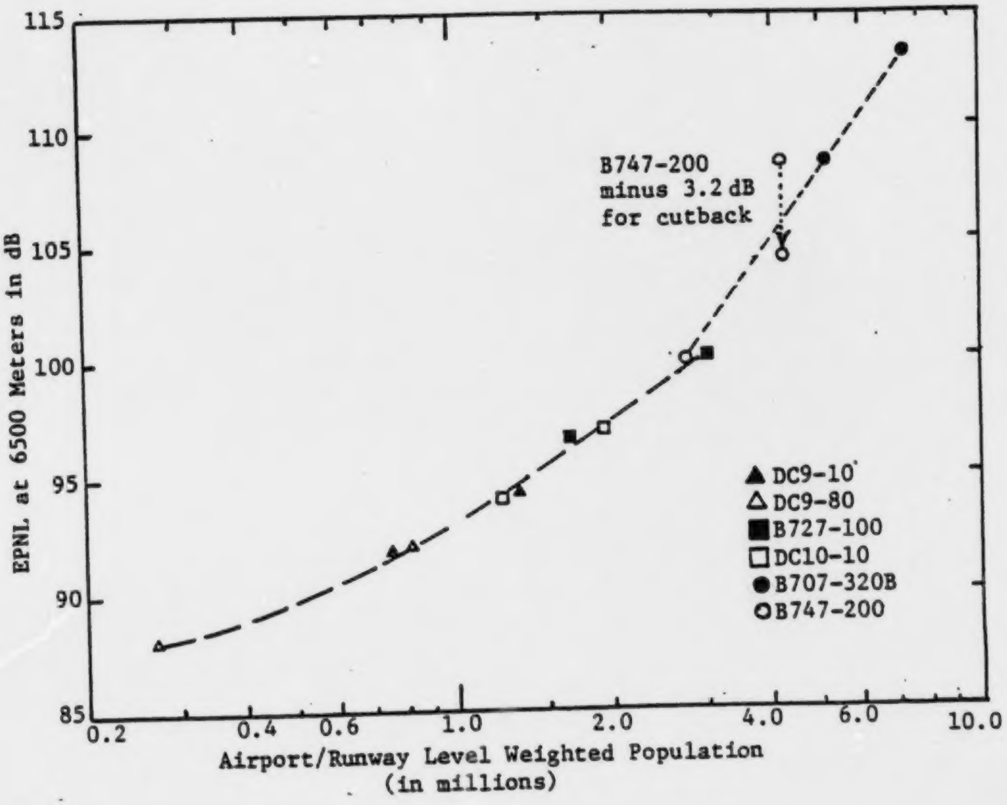

FIG. 14 VARIATION IN *AIRPORT/RUNWAY* WEIGHTED POPULATION WITH EPNL AT THE 6500 METER MEASUREMENT LOCATION FOR PROCEDURE 3a INITIATED AT AN ALTITUDE OF 305 METERS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS. NOTE THAT THE POPULATION FOR 4-ENGINED AIRCRAFT IS BASED ONLY ON THE Y POPULATION CATEGORY, WHILE THAT FOR 2- AND 3-ENGINED AIRCRAFT IS BASED ON ALL CATEGORIES.

they should remain generally valid for these aircraft, after appropriate rescaling, if the values assumed in this study for EPNL vs slant distance, thrust cutback, thrust cutback noise reduction and climb performance were to be changed by moderate amounts.

4.2 Effect of Resumption of Climb Thrust at an Altitude of 914 Meters in Procedures 1b and 3b

Practical operational procedures that utilize a maximum thrust cutback resume standard climb thrust at some altitude, usually between 914 and 1219 meters, or at a distance from start of takeoff roll that is beyond significant population. For this study the resumption of climb thrust (or minimum thrust cutback) was assumed to occur at an altitude of 914 meters.

For 2- and 3-engined aircraft with low bypass ratio engines, there is a significant increase in the *airport/runway level* weighted population and in the areas enclosed by EPNL contours of 85 and 90 dB when climb thrust is resumed, see Table 8. For 2- and 3-engined aircraft with high bypass ratio engines there is a tendency towards a slight increase when climb thrust is resumed, and the only effect on area is found within the EPNL contour of 85 dB. For these aircraft one would expect a more significant increase if levels below EPNL 85 were examined and included in the calculation of area and *airport/runway level* weighted population.

For the 4-engined aircraft the results show little effect of resuming climb thrust, with the exception of procedure 1b with the B707-320B at 260,000 lbs gross weight. For this aircraft significant changes in area are noted within contours defined by EPNL values of 95 and lower, but these changes tend to occur at a relatively great distance from the airport where the population densities are relatively low and thus do not significantly affect the *airport/runway weighted* population.

TABLE 8. COMPARISON OF THE RATIO OF *AIRPORT/RUNWAY LEVEL* WEIGHTED POPULATION DEFINED AS THE VALUE FOR THE PROCEDURES (1b AND 3b) WITH POWER RESUMPTION AT 914 METERS ALTITUDE DIVIDED BY THE VALUE FOR THE PROCEDURES (1a AND 3a) WITHOUT POWER RESUMPTION AFTER MAXIMUM THRUST CUTBACK.

AIRCRAFT	WEIGHT (1000 lbs)	CLEANUP BEFORE CUTBACK PROCEDURES 1a AND 1b			CUTBACK BEFORE CLEANUP PROCEDURES 3a AND 3b			Highest EPNL at Which Area is Increased by Power Resumption (dB)*	Distance (km.) to Altitude of 914 meters for Initiation at 305 Meters**
		Inititation Altitude (meters)			Initiation Altitude (meters)				
		122	305	610	122	305	610		
DC9-10	80.0	2.16	1.83	1.57	2.07	2.46	2.32	90/90	8.5/9.8
	90.7	1.54	1.45	1.32	1.64	1.77	1.99	90/90	9.9/10.4
DC9-80	112.0	1.03	1.02	1.02	1.05	1.07	1.09	85/85***	8.5/11.8
	140.0	1.00	1.00	0.99	1.04	1.13	1.03	85/85	11.5/13.3
B727-100	135.0	1.11	1.11	1.40	1.29	1.48	1.77	90/90	13.6/18.4
	160.0	1.06	1.15	1.26	1.11	1.74	1.29	90/90	16.5/19.7
DC10-10	370.0	1.04	1.05	0.95	1.05	1.11	1.15	85/85	11.7/19.1
	440.0	1.05	1.02	1.02	1.08	1.05	1.07	85/85	17.3/23.7
B707-320B	260.0	1.08	1.24	1.13	0.99	0.95	1.06	95/95	15.0/21.0
	333.6	1.03	1.04	1.03	0.97	0.99	0.96	95/95	20.0/23.3
B747-200	625.0	1.05	1.05	1.04	1.00	0.99	1.04	85/90	14.7/21.7
	775.0	1.00	1.00	0.99	1.00	1.00	1.00	85/85****	20.7/28.7

*90/85 means that the area for procedure 1b is significantly greater (i.e., more than a few percent) than that of procedure 1a at EPNL contours of 90 and 85, and that the area for procedure 3b is significantly greater than that of procedure 3a at the EPNL contour of 85 dB. No significant difference in area is observed for EPNL contours of higher levels.

**Distance 1a/Distance 3a (same values apply to 1b/3b).

***Just noticeable difference.

****85 dB contours for procedures 3a and 3b did not close in the grid used for computation.

4.3 Comparison of the Four Basic Procedures, 1a, 2, 3a, and 4

It has been generally accepted [23] that procedures that initiate thrust cutback before cleanup benefit the near airport neighbors more than do procedures that initiate cleanup before thrust cutback, whereas the latter procedures are relatively more favorable to the more distant residents. However, the nature and magnitudes of the tradeoffs among these alternative procedures, as they relate to area-level, population-level and population-impact functions, have not been generally defined. Finally, because of the interactions among the several parameters involved in these tradeoffs, it is not always intuitively clear as to which are the best procedures for specific aircraft types. This section endeavors to use the data of this study to clarify these issues.

Contour Length

Figure 15 gives three examples of the relationships between contour length and level for the four basic procedures when initiated at an altitude of 305 meters. Of these examples, the B727-100 at maximum gross weight shows the greatest variation amongst procedures. Procedure 3a produces the lowest levels and shortest contour lengths for distances between 4 and 10 km from start of takeoff roll and EPNL values greater than 96 dB. Beyond a distance of 10 km and below an EPNL of 96 dB, procedure 1a produces the lowest levels and shortest contour lengths. The thrust cutback for procedure 3a occurs at a distance of 4.4 km, and that for procedure 1a occurs at 9.9 km. Thus, procedure 3a is superior over the range of distances in which its thrust is cut back and the thrust for procedure 1a is not cut back. For distances beyond the distance at which thrust is cut back in procedure 1a, it becomes superior because the aircraft is higher, faster and has a greater thrust cutback, see Appendix B.

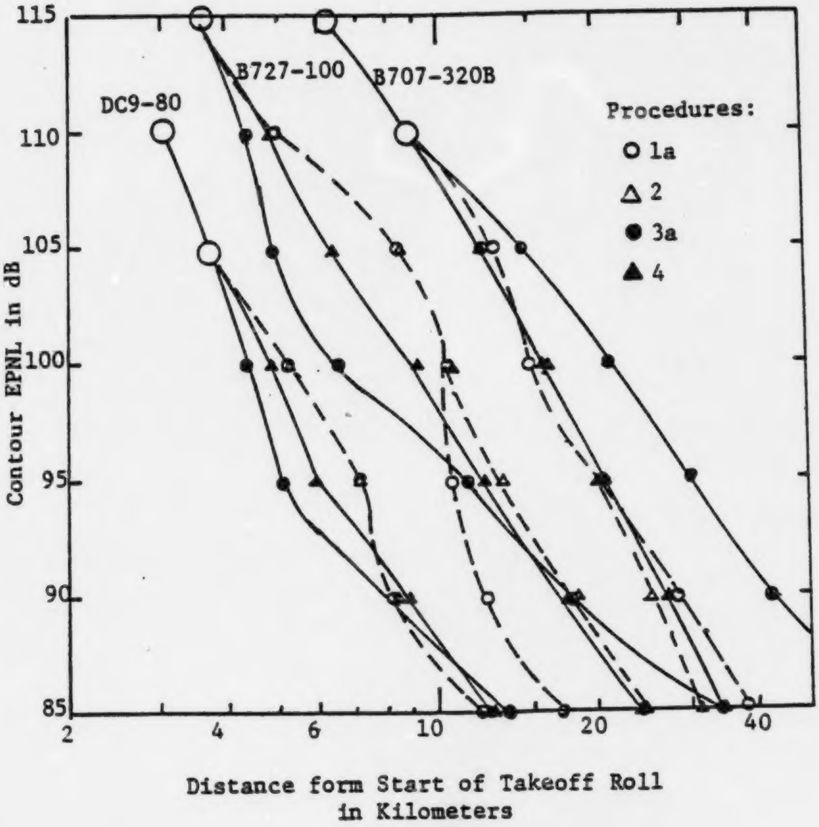

FIG. 15 EXAMPLES OF THE VARIATION OF CONTOUR LENGTH WITH 4 FLIGHT PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS FOR 3 AIRCRAFT AT MAXIMUM GROSS WEIGHT.

The B727-100 results for procedure 4 are intermediate between those of procedures 3a and 1a (and 2 which is identical to 1a in this region) at distances between 4 and 10 km. At distances between 10 and 17 km., procedures 2 and 4 have the highest levels of all four procedures with those of procedure 2 slightly greater than those of procedure 4. At distances beyond 17 km. procedure 3a has the highest levels, procedures 2 and 4 become almost identical and have intermediate levels and procedure 1a has the lowest levels.

The results in Figure 15 for the DC9-80 aircraft are similar to those of the B727-100 except that the variation among procedures is somewhat less and the regions in which a procedure is superior to another occur at different distances. For this aircraft, the thrust cutback for procedure 3a occurs at a distance of 4.3 km., and the cutback for procedure 1a occurs at a distance of 7.2 km. Between these two distances procedure 3a has lower levels than does procedure 1a; beyond 7.2 km. procedure 1a has lower levels.

The results in Fig. 15 for the B707-320B are somewhat different from those of the other two aircraft. Procedure 3a has higher levels at all distances beyond 9 km,, and procedure 1a is superior only between the distances of 13.6 km. (thrust cutback distance for procedure 1a) and about 18 km. For distances greater than 18 km. where procedure 2 ends its acceleration to 250 knots, it has the lowest levels, with increasingly higher levels resulting from procedures 4, 1a, and 3a in sequence. This sequence of levels for the four procedures beyond 18 km. is in accord with the sequence of the altitudes of the aircraft shown in Fig. 3. The relatively small variation for this aircraft among procedures 1a, 2, and 4, as well as the significantly poorer performance of 3a, is considered to result from the combination of its very small noise reduction with thrust cutback (approximately 2 dB for procedure 3a) and its relatively lower altitude as a function of distance. These factors also explain why the minimum cutback procedures become superior after 18 km. because they sacrifice little noise reduction, but achieve better climb performance.

Table 9 provides for all of the aircraft-weight combinations the distances to cutback and the values of EPNL at the four positions between 4.7 km. and 12.8 km. for procedure 1a initiated at both 122 and 305 meters altitude and for procedure 3a initiated at 305 meters altitude. These data show that the general conclusions reached from Fig. 15 apply to all aircraft-weight combinations.

Contour Area

Figure 16 illustrates the relationships between contour area and contour EPNL for the four procedures and the three example aircraft used above. The same general conclusions can be drawn from examination of areas in Fig. 16 as from lengths in Fig. 15, except that the contour values of EPNL which bound the region of one procedure's superiority over another are lower for areas than for lengths. For example, in Fig. 16 for the B727-100 aircraft, procedure 1a becomes superior for contour area to procedure 3a for values of EPNL lower than 87 dB, whereas for contour length it became superior for values of EPNL lower than 96 dB. Similarly, for the DC9-80, procedure 3a is still slightly superior for contour area to procedure 1a, at the lowest calculated value of EPNL (85 dB), whereas for contour length it became superior at an EPNL of approximately 90 dB.

These differences imply differences in the shapes of the contours as a function of both contour level (or size) and procedure. Fig. 17 illustrates the relationship between contour area and contour length for the B727-100 at maximum gross weight. For the contours between an EPNL of approximately 100 and 110 dB, the contours of procedure 1a have a greater area and length than do those of procedure

TABLE 9. SUMMARY OF DISTANCES FROM START OF TAKEOFF ROLL TO THRUST CUTBACK AND EPNL VALUES AT 4 POSITIONS FOR ALL AIRCRAFT-WEIGHT COMBINATIONS AND 3 PROCEDURES* WITH MAXIMUM THRUST CUTBACK.

AIRCRAFT	WEIGHT (1000 lbs)	DISTANCE (km.) TO THRUST CUTBACK			EPNL (dB) AT 4700 METERS			EPNL (dB) AT 6500 METERS			EPNL (dB) AT 9200 METERS			EPNL (dB) AT 12600 METERS		
		Procedure 1a Initiated		Procedure 3a Initiated	Procedure 1a Initiated		Procedure 3a Initiated	Procedure 1a Initiated		Procedure 3a Initiated	Procedure 1a		Procedure 3a Initiated	Procedure 1a Initiated		Procedure 3a Initiated
		@ 122 Meters	@ 305 Meters	@ 305 Meters	@ 122 Meters	@ 305 Meters	@ 305 Meters	@ 122 Meters	@ 305 Meters	@ 305 Meters	@ 122 Meters	@ 305 Meters	@ 305 Meters	@ 122 Meters	@ 305 Meters	@ 305 Meters
DC9-10	80.0	4.2	5.3	2.4	97.4	102.2	95.4	89.5	90.6	92.0	84.6	83.5	88.2	80.4	79.1	84.5
	90.7	5.4	6.8	3.0	105.9	104.8	98.4	94.1	100.4	94.5	87.9	87.8	90.4	83.3	82.7	86.6
DC9-80	112.0	3.9	5.0	2.9	92.7	96.3	90.6	88.9	87.9	88.1	84.6	83.9	85.1	80.9	80.5	82.1
	140.0	5.6	7.2	4.3	102.6	101.0	96.4	93.7	96.9	92.2	89.1	88.3	88.9	85.2	84.6	85.7
B727-100	135.0	5.5	6.7	3.2	109.5	107.6	99.5	96.7	103.4	96.7	91.0	89.7	93.6	86.7	85.0	90.2
	160.0	8.4	9.9	4.4	113.1	110.4	105.7	109.7	107.5	100.0	97.6	103.8	97.0	90.7	89.3	93.8
DC10-10	370.0	8.1	10.0	3.8	101.6	99.4	96.4	97.6	96.1	94.2	90.5	91.9	91.8	86.3	85.6	89.3
	440.0	11.1	13.6	5.3	105.2	103.6	103.5	101.5	99.1	96.8	97.4	95.7	94.0	90.9	92.1	91.2
B707-320B	260.0	6.5	8.2	3.9	114.4	112.5	110.7	108.2	108.3	108.5	101.3	99.2	105.4	98.1	95.5	102.2
	333.6	10.9	13.6	6.3	121.4	120.8	120.8	116.2	114.1	113.1	111.3	109.4	109.8	103.5	104.8	106.5
B747-200	625.0	9.4	11.5	4.6	109.5	107.6	106.1	105.2	103.7	99.8	100.2	99.5	97.5	91.1	90.7	94.9
	775.0	14.9	15.4	6.9	115.9	116.1	116.1	110.4	108.7	108.6	105.2	104.1	100.9	100.9	100.1	98.5

*Note that procedure 3a has a larger thrust cutback than allowed by FAR Part 25. If it had been calculated with the FAR Part 25 allowable cutback the EPNL values *after cutback* for procedure 3a would be increased by about 2 dB for the first three aircraft and by about 1 dB for the last three aircraft.

3a. However, for contours associated with values of EPNL between 85 and 95 dB there is an increasing tendency for the contours of procedure 3a to become significantly longer than those of procedure 1a, given when the areas are similar. It is clear that much of the area associated with procedure 1a occurs in the early part

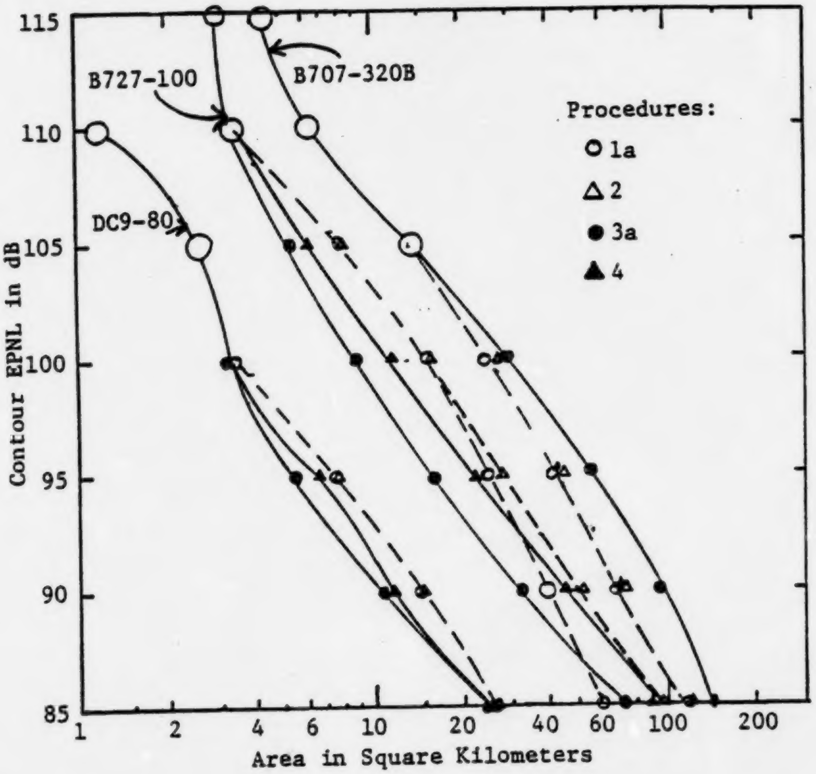

FIG. 16 EXAMPLES OF THE VARIATION OF CONTOUR AREA WITH 4 FLIGHT PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS FOR 3 AIRCRAFT AT MAXIMUM GROSS WEIGHT.

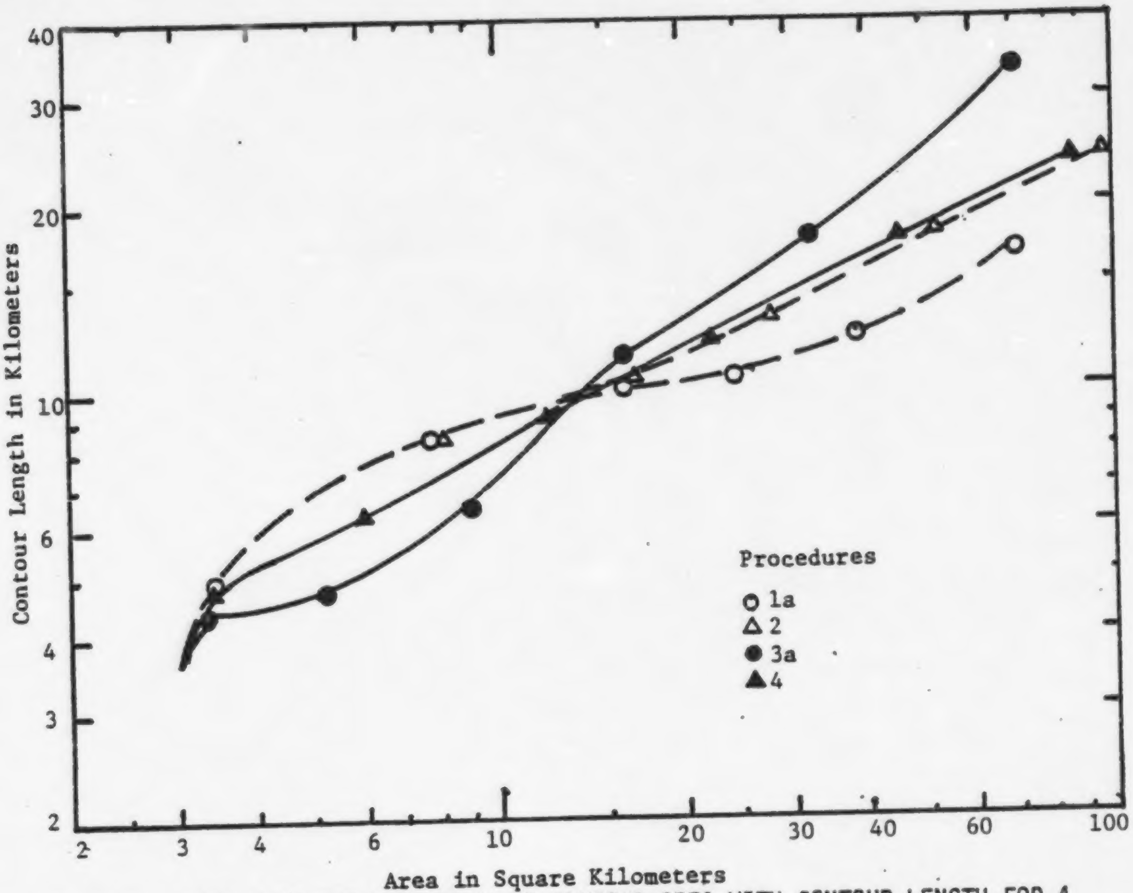

FIG. 17 EXAMPLE OF THE VARIATION OF CONTOUR AREA WITH CONTOUR LENGTH FOR 4 PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS FOR B727-100 AT MAXIMUM GROSS WEIGHT.

of the takeoff when the aircraft is at full takeoff thrust, whereas much of the area for the lower values of EPNL associated with procedure 3a, occurs further from the airport where the aircraft thrust is cut back and its climb rate is low.

This conclusion also indicates that some of the area associated with the lower valued EPNL contours for procedure 1a occurs at considerable distances to the sideline and at low elevation angles, particularly for the B727-100 aircraft. The magnitudes of such areas are therefore susceptible to any attenuation due to aircraft shielding and possible attenuation effects at elevation angles above 7.4° — the limit of the transition region between ground-to-ground and air-to-ground attenuation in the Noisemap computer program. To the extent that Noisemap may overpredict these sideline areas at low elevation angles, the areas at low values of EPNL for procedure 1a may be artificially increased in the computation relative to those of procedure 3a. However, this caution does not apply to the contour areas associated with higher values of EPNL, and their associated higher elevation angles, which result from noise radiated from the aircraft in the procedure 1a acceleration segment.

Airport/Runway Level Weighted Population

The *airport/runway level* weighted population data provide a single number outcome for each procedure which is intended to be related to noise impact. As noted in Section 2, these data should be used to reflect general trends amongst procedural alternatives, rather than for their absolute magnitudes. Further, absolute comparisons among procedures, aircraft and other factors should be stated with caution since the data in Fig. 14 indicate that a change of one dB results in a change of ten to twenty percent in the value of *airport/runway level weighted population* (ARLWP).

Table 10 summarizes the data for the three example aircraft discussed above. For the B727-100 and the DC9-80 aircraft the ranking of the procedures in terms of ARLWP is identical to their ranking in terms of contour area for EPNL values of 95 dB and above for the B727-100, and those above 85 dB for the DC9-80. Examination of the detailed results in Appendix A for these aircraft shows that the significant differences between procedures 1a and 3a in contribution to ARLWP occur in the higher valued EPNL contours where any differential elevation angle effects should be negligible. For the B707-320B the differences in ARLWP are proportionally quite small and result from small differences in area at various levels, depending upon procedure, see the detailed data in Appendix A.

TABLE 10 *AIRPORT/RUNWAY* LEVEL WEIGHTED POPULATION (MILLIONS) FOR THE DC9-80, B727-100 AND B707-320B AIRCRAFT AT MAXIMUM GROSS WEIGHT FOR 4 PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS.

AIRCRAFT	PROCEDURE			
	Cleanup Before Cutback		Cutback Before Cleanup	
	1a) Max Cutback	2) Min Cutback	3a) Max Cutback	4) Min Cutback
DC9-80	1.19	1.19	0.82	1.08
B727-100	5.10	6.70	3.07	5.37
B707-320B	6.75	7.02	7.32	6.55

Table 11 presents similar ARLWP data for the four basic procedures for the six aircraft at both weights and three intiation altitudes. The table also gives the average of the 12 values for each aircraft-weight combination and the ratio (R) of the standard deviation divided by the average.

The variation in ARLWP among procedures, as measured by the ratio (R), is higher for the 2- and 3-engined narrow body aircraft than for the 4-engined aircraft. For this latter category at maximum gross weight there is little variation among the procedures. For the B747-200 the differences amongst procedures are very small and probably well within the errors inherent in this study. For the B707-320B at an initiation altitude of 305 meters procedure 3a appears least desirable and either procedure 1a or 4 most desirable, depending on weight.

TABLE 11 *Airport/Runway Level* Weighted Population (millions) for the 4 Basic Procedures, 1a, 2, 3a and 4, for 6 Aircraft, both Weights and 3 Initiation Altitudes, 122, 305, and 610 Meters.

AIRCRAFT	Weight (1000 lbs)	CLEANUP BEFORE CUTBACK						CUTBACK BEFORE CLEANUP						AVERAGE VALUES	
		1a) Maximum Cutback			2) Minimum Cutback			3a) Maximum Cutback			4) Minimum Cutback			Avg.	R=Std.Dev./Avg.
		122	305	610	122	305	610	122	305	610	122	305	610		
DC9-10	80	0.77	1.15	1.53	2.14	2.08	2.44	0.89	0.75	0.88	1.95	2.14	2.24	1.58	0.41
	90.7	1.44	2.06	2.55	2.81	3.16	3.01	1.35	1.33	1.49	2.65	2.77	3.03	2.30	0.31
DC9-80	112	0.39	0.47	0.63	0.47	0.52	0.64	0.38	0.27	0.32	0.50	0.45	0.53	.46	0.24
	140	1.07	1.19	1.41	1.07	1.19	1.39	0.81	0.82	0.72	0.96	1.08	1.19	1.08	0.20
B727-100	135	2.16	3.33	3.74	4.25	4.43	4.79	1.97	1.65	1.91	4.14	4.00	4.23	3.38	0.34
	160	4.68	5.10	5.77	6.02	6.70	7.17	2.38	3.07	3.95	5.07	5.37	5.78	5.09	0.28
DC10-10*	370	1.34	1.35	1.45	1.42	1.42	1.37	1.64	1.22	1.06	1.29	1.29	1.24	1.34	0.10
	440	2.03	2.21	2.14	2.43	2.37	2.20	1.94	1.95	1.82	2.21	2.19	2.12	2.13	0.08
B707-320B	260	3.91	3.52	4.08	4.24	4.41	4.59	5.84	5.15	4.17	4.02	4.08	4.32	4.36	0.14
	333.6	6.61	6.75	6.95	6.81	7.02	7.19	8.11	7.32	7.33	6.29	6.55	6.83	6.98	0.07
B747-200	625	2.78	2.89	2.93	2.93	3.07	3.03	3.18	2.77	2.65	2.77	2.71	2.87	2.88	0.06
	775	4.44	4.42	4.63	4.47	4.54	4.60	4.35	4.31	4.48	4.15	4.27	4.42	4.42	0.03

*The lift drag ratio used for clean climb for the DC 10-10 in this study is lower than the current updated value (see Appendix B). If the updated value had been available and used the aircraft would have climbed at a higher angle after cleanup and the data shown here for procedures 1a, 2, and 4 would be somewhat reduced.

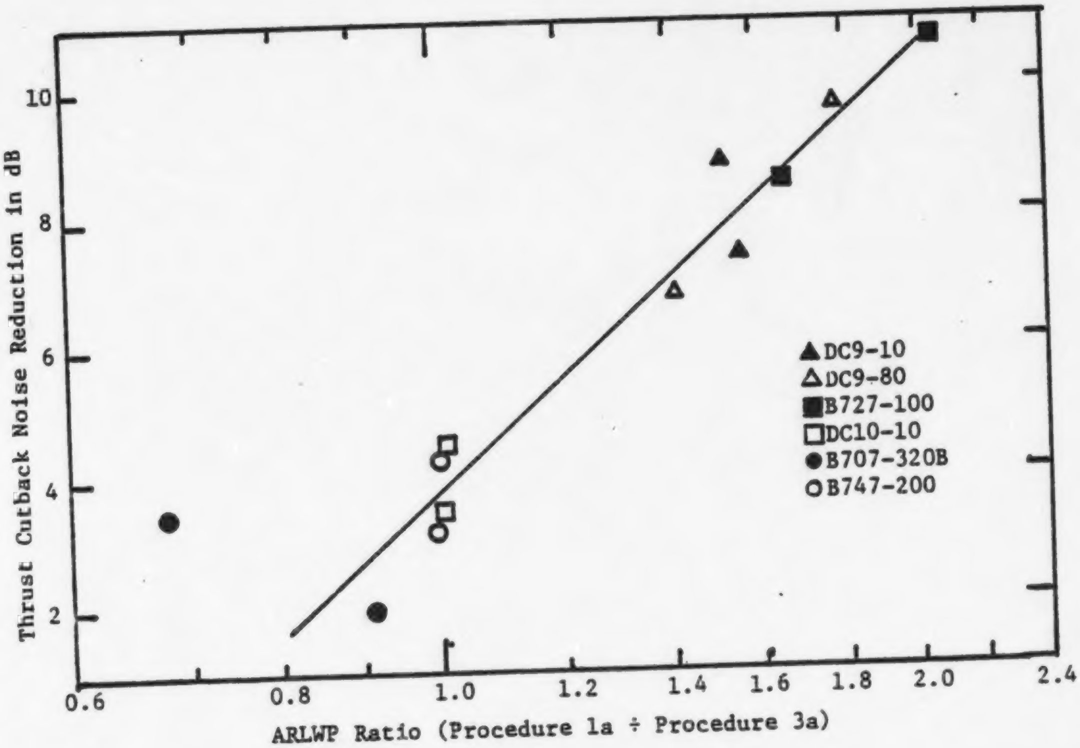

FIG. 18 RATIO OF THE VALUE OF *AIRPORT/RUNWAY LEVEL* WEIGHTED POPULATION FOR PROCEDURE 1a DIVIDED BY THE VALUE FOR PROCEDURE 3a WITH BOTH PROCEDURES INITIATED AT AN ALTITUDE OF 305 METERS.

For the 2- and 3-engined aircraft most of the values of ARLWP associated with maximum cutback either before (procedure 3a) or after (procedure 1a) cleanup are lower than the corresponding values associated with minimum cutback (procedures 4 and 2, respectively). This effect is most pronounced with the DC9-10 and B727-100 aircraft which have low bypass ratio engines and higher values of noise reduction with maximum thrust cutback than those obtained for the high bypass ratio engines on the two comparative aircraft.

Of the two procedures that have maximum cutback, procedure 3a results in lower values of ARLWP than does procedure 1a for three of the four aircraft when both procedures are initiated at the same altitude of 305 meters. Fig. 18 compares the ratios of the values of ARLWP for procedure 1a divided by the values for procedure 3a as a function of the noise reduction associated with thrust cutback in procedure 3a. The results indicate that maximum cutback before cleanup, procedure 3a, may be expected to have lower values of ARLWP when the noise reduction for that procedure is greater than approximately 5 dB. For the three airplanes that meet this criteria, the DC9-10, DC9-80 and B727-100, this conclusion would be expected to remain true for a procedure similar to 3a, but meeting the FAR Part 25 climb requirements. These requirements, a one engine out climb gradient of 0.012 for 2-engined aircraft and 0.015 for 3-engined aircraft, would necessitate greater thrust than required for the level flight FAR Part 36 procedure, reducing the noise reduction for these aircraft by 1 to 2 dB from the values in Fig. 18, depending on aircraft-weight combination.

The data in Table 11 for procedure 1a show a consistent increase in the values of ARLWP with an increase of initiation altitude. The primary reason for this trend appears to be that the distance from start of takeoff roll to the location of thrust cutback is shorter when acceleration is initiated at a lower altitude.

Consequently, because procedure 1a has a greater impact than does procedure 3a over the distance between the cutback locations for the two procedures, as shown in Figs. 15, 16, 17 and in Table 8, lower values of ARLWP would be expected for the shorter distances.

A similar, but less consistent, trend can be observed for procedure 2. Here, the magnitude of the effect is much less because with minimum thrust cutback proportionately more of the total impact occurs in region after thrust cutback. No consistent trend between initiation altitude and ARLWP is observed for procedures 3a, 3b and 4. However, an examination of the relative areas shows the expected changes for procedure 3. For the contour areas associated with higher values of EPNL the areas increase with an increase in the altitude at which cutback is initiated, as a result of the greater distance at maximum thrust. Conversely, for the contour areas associated with the lower values of EPNL the areas decrease with an increase in the altitude at which cutback is initiated. This decrease is the net result of the increase in these areas to the side of the maximum thrust initial climb and the decrease in these areas at larger distances after cutback.

An approximate adjustment to the ARLWP for procedure 3a initiated at 305 meters can be made to account for the one to two dB increase in noise that would occur if the thrust cutback were constrained to the FAR Part 25 requirements. This approximate adjustment can be made using either the results of Fig. 18 or those of Fig. 14, together with the cutback noise level appropriate to the increased value of thrust. The results of such an adjustment for the 2- and 3-engined aircraft are tabulated in Table 12. With the exception of the B727-100 at maximum gross weight, these results indicate that procedure 1a initiated at 122 meters has essentially the same magnitude of ARLWP as would a procedure 3a initiated at

305 meters and meeting the FAR Part 25 thrust requirements. However, as previously noted, the results for the adjusted procedure 3a are superior to those of procedure 1a when both procedures are initiated at an altitude of 305 meters.

This general reduction of ARLWP with initiation altitude for cleanup before maximum cutback (procedure 1a) is further confirmation of the practice of reducing the amount of takeoff flap extension. Further, for minimizing noise impact it suggests that takeoffs should be made with both minimum flap (higher takeoff velocity) and with *maximum* available thrust, not reduced thrust.

All of these comparisons involving ARLWP are generalized to the average population density distance functions for the sum of 304 airports. For a specific airport the optimum procedure having least impact depends on the distribution of population as a function of distance along, and to the side of, each flight track from the airport and the type and weight of the aircraft. However, the general principles are clear. For both 2- and 3-engined aircraft, and for 4-engined aircraft that have significant noise reduction with thrust cutback:

- If the populated area is close to the airport, attain maximum altitude before reaching the populated area, then initiate maximum cutback and subsequently resume climb thrust after passing the area, or when reaching an altitude when the noise on the ground is less than a selected value.
- If the populated area is far enough from the airport to allow completion of partial or complete cleanup before reaching the populated area, (see Table 9) initiate acceleration and cleanup at the lowest safe altitude, then initiate maximum cutback at the beginning of the populated area, and resume climb thrust as above.

TABLE 12. COMPARISON OF ESTIMATED *AIRPORT/RUNWAY LEVEL* WEIGHTED POPULATION (MILLIONS) FOR 2- AND 3-ENGINED AIRCRAFT AND FOR CLEANUP BEFORE MAXIMUM CUTBACK INITIATED AT 122 METERS WITH MAXIMUM CUTBACK BEFORE CLEANUP INITIATED AT 122 AND 305 METERS WITH AND WITHOUT ADJUSTMENT OF THRUST TO COMPLY WITH FAR Part 25.

AIRCRAFT	Weight (1000 lbs)	CLEANUP BEFORE MAX CUTBACK (1a) @ 122 METERS	MAX CUTBACK BEFORE CLEANUP (3a)		
			As Calculated		Adjusted for Part 25 Thrust
			@ 122 Meters	@ 305 Meters	@ 305 Meters
DC9-10	80	0.77	0.89	0.75	0.86
	90.7	1.44	1.35	1.33	1.57
DC9-80	112	0.39	0.38	0.27	0.31
	140	1.07	0.81	0.82	0.98
B727-100	135	2.16	1.97	1.65	2.01
	160	4.68	2.38	3.07	3.84
DC10-10	370	1.34	1.64	1.22	1.35
	440	2.03	1.94	1.95	2.18

*No adjustment was calculated for cutback at 122 meters (3a), although it is presumed that an adjustment would increase the calculated values of ARLWP.

For 4-engined aircraft that do not have significant noise reduction with thrust cutback attain the maximum altitude before reaching the populated area, then initiate minimum cutback and proceed to cleanup and climb.

4.4 Development of Goals for Aircraft Noise

This subsection discusses possible applications of the results of this study in the development of goals for the takeoff noise of future aircraft and some of the implications of such goals with respect to FAR Part 36 certification requirements.

Goals

The data in this report provide approximate relationships between the contour area for a given procedure and the EPNL at 6500 meters, EPNL with thrust cutback at 305 meters and population for three population density categories. These relationships, together with the approximate relationship between the EPNL of a fleet average aircraft and NEF for each population density category, can be used to consider the implications of selecting alternative goals for aircraft noise. The use of this information is illustrated in the following paragraphs.

The relationships between EPNL for a fleet average (noise energy) aircraft and NEF for the operations of an average runway in each population density category given in Table 5 were:

- for Population Category X, NEF 30 is equivalent to an EPNL of 96 dB
- for Population Category Y, NEF 30 is equivalent to an EPNL of 96.5 dB
- for Population Category Z, NEF 30 is equivalent to an EPNL of 108 dB.

If another value of NEF is selected, the value of EPNL would change from that given above by the same amount as the new value of NEF differed from 30. Categories X and Y clearly dominate any fleet wide goal development because they are both more restrictive in

EPNL than is Category Z. Category Y is chosen here for analysis instead of Category X because it represents 54 airports with an estimated 216 runway ends and has operations of all aircraft types, whereas Category X has only two airports and does not have 4-engined aircraft operations.

The next step is to choose one or more sets of values of NEF and population as trial goals. For this example the two trial goals are negligible population within NEF values of 30 and 40 dB. Fig. 19 contains two values of area vs population for Category Y for most of the twelve aircraft-weight combinations. The values were selected from procedures 3a and 4 to represent the maximum area without populations and the minimum area with populations. These data indicate that, with one exception, negligible population is expected to reside within a contour area of 3 sq. km. or less. Note that these data are averages; therefore, one should expect that some population will be found within the 3 sq. km. contours, particularly at the busiest airports that are surrounded by close-in neighbors, and at airports where runway utilization varies significantly from the average.

Table 13 summarizes several outcomes for these two examples, using procedure 3a initiated at 305 meters. For the NEF 30 goal the fleet average aircraft would require a cutback EPNL of 91.5 dB at 305 meters, a flyover EPNL at 6500 meters of 86.5 dB and would result in approximately 650,000 population within NEF 20, considering only Category Y airports. This value of 86.5 dB is 1.6 dB less than the DC9-80 and 7.7 dB less than the DC10-10, both at their typical weights. If the noise levels of these two aircraft were scaled to a possible future fleet average aircraft with a typical weight of 180,000 lbs (max gross weight of 220,000 lbs) the average EPNL at 6500 meters is 90.6 dB, 4.1 dB more than that required to meet this trial goal. To achieve the trial goal of NEF 30 with this

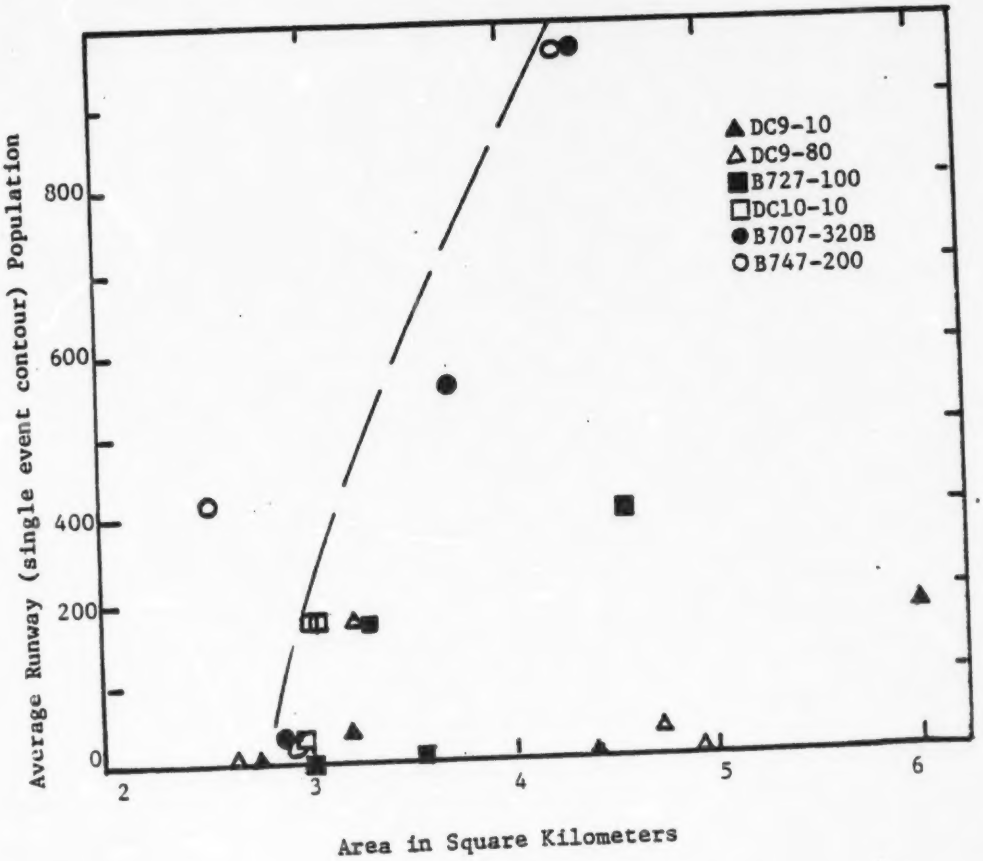

FIG. 19 MINIMUM VALUES OF POPULATION AND CONTOUR AREA FOR PROCEDURES 3a AND 4 INITIATED AT AN ALTITUDE OF 305 METERS.

TABLE 13. EXAMPLE OF ALTERNATIVE GOALS USING DATA FOR PROCEDURE 3a, INITIATED AT AN ALTITUDE OF 305 METERS.

QUANTITY	N E F				SOURCES
	30		40		
Basic Relationships EPNL for Category Y	96.5		106.5		From Table 5
Contour Area for Negligible Population (sq.km.)	3		3		From Fig. 19
Fleet Avg Aircraft EPNL (cutback) @ 305 M	91.5		101.5		From Fig. 12
Fleet Avg. Aircraft EPNL (cutback) @ 6500 M*	86.5		96.5		From Fig. 11
APPROXIMATE RESULTS	Contour Area (sq.km.)	Total Pop. in Y (1000s)	Contour Area (sq.km.)	Total Pop. in Y (1000s)	
Within NEF 35	--	--	6	200	Figs. 8 & 11
Within NEF 30	3	--	9	650	Figs. 8 & 11
Within NEF 25	6	200	18	2160	Figs. 8 & 11
Within NEF 20	9	650	40	5830	Figs. 8 & 11

*For procedure 4 these values would be increased by about 3 dB hypothetical aircraft at maximum gross weight would require a 7.5 dB reduction in its EPNL at 6500 meters.

These requirements are also a function of the procedure that is to be used. If procedure 4 (minimum thrust cutback) initiated at 305 meters is selected, rather than 3a, the maximum values of EPNL at 6500 meters become 89.5 and 99.5 for NEF 30 and 40 trial goals, respectively. The maximum EPNL at 6500 meters for the NEF 30 trial goal is approximately 2.5 dB less than would be expected for the hypothetical high bypass ratio 180,000 lb. typical weight aircraft at minimum thrust cutback. The maximum EPNL at 6500 meters for the NEF 40 trial goal in Table 13 is about 2 dB less than the B727-100 with minimum cutback at 305 meters altitude and typical weight, and 5 dB less than the B727-100 with minimum cutback at 305 meters altitude and maximum weight.

Implications for Certification

The flight procedures examined in this study and those recommended by the FAA [9] provide that the acceleration and/or cutback procedure in the second climb segment be initiated at a specific altitude for all aircraft and all weights. However, in the certification test procedure the aircraft continues its initial climb to the maximum possible altitude before initiating maximum cutback in order to achieve the minimum possible EPNL at the 6500 meter measurement location. For 4-engined civil aircraft at maximum gross weight cutback for certification is usually initiated at an altitude in the vicinity of 305 meters. However, the cutback initiation altitudes for 2- and 3-engined aircraft are significantly higher, with the smaller DC9s reaching an altitude of approximately 800 meters before cutback. Because of this fundamental conceptual difference between typical operational procedures and certification procedures, it is difficult to obtain a direct translation of data from one to the other, particularly for 2- and 3-engined aircraft.

Stated another way, the two types of procedures have a subtle variance, illustrated by the following two sets of questions posed to the aircraft and its designers.

The certification procedure asks:

- How much is your noise reduction with maximum thrust cutback?
- How much is your maximum thrust noise as a function of distance? and
- How high can you fly in a fixed distance?

Whereas the operational procedure asks:

- How much is your noise reduction with maximum thrust cutback?
- How much is your maximum thrust noise as a function of distance? and,
- How far do you have to fly to reach a fixed altitude?

The first question is common to both procedures. The answer depends on the takeoff thrust-weight ratio, the aircraft's drag-lift ratio, the rate of change of noise with change in thrust for the engine type, the number of engines and the one engine out thrust requirements. For high bypass-ratio engines the rate of change of noise level with thrust is approximately 20 times the logarithm of the thrust ratio, whereas with low bypass ratio engines it is more typically proportional to 40 times the same logarithm. For an aircraft with three high bypass ratio engines the noise reduction increases by about 0.8 dB per 10 percent increase in installed maximum thrust to weight ratio, or per 10 percent decrease in drag-lift ratio. For an aircraft with three low bypass ratio engines the noise reduction values double to 1.6 dB per 10 %

change in either parameter. For any given set of values for thrust-weight ratio and drag-lift ratio the maximum amount of thrust reduction is constrained by FAR Part 25 or 36 requirements for engine out performance and minimum rate of climb. These requirements generally allow slightly greater relative thrust reduction on 3-engined than on 2- or 4-engined aircraft.

It is doubtful that the thrust-weight ratio would be altered significantly in the design of practical aircraft simply to produce a noise benefit, although paper designs of SST aircraft have investigated this possibility. [24] There are a great number of constraints on the takeoff thrust-weight ratio including: FAR Part 25 requirements for a one engine out condition which lead to higher values of thrust to weight ratios for aircraft with fewer engines; desired field length as a function of objectives for missions, payload, airport altitudes and maximum hot day temperatures; cruise speed, drag and fuel consumption, and the engine cycle characteristics of net thrust vs speed. However, improvements may be found in reductions of the drag-lift ratio through improved low-speed aerodynamic configurations, increases in the rate of change of noise for a change in thrust, and possibly engine cycles which provide a higher ratio of takeoff to cruise net thrust.

The second question is also common to both procedures. The answer is a function of the basic design of the engine, the magnitude of its noise as a function of distance and the altitude achieved at the fixed distance. When scaled to the same maximum thrust the high bypass ratio engines, as installed in the aircraft used in this study, are about 9 to 14 dB quieter than the average of the low bypass ratio engines, with the DC10-10 engine being the quietest. As shown in Fig. 5, all aircraft except the B707-320B had similar noise vs distance characteristics. The improvement in noise resulting from the development of high bypass ratio engines is the most significant reason for the improvement in the noise of new aircraft. Further improvements could be achieved by the development of even higher bypass ratio engines with minimum noise fan blade designs, optimum acoustic treatment and minimization of residual core noise.

The answers to both of these first two questions demonstrate similar effects on the noise at 6500 meters under both types of flight procedures, except that for 2- and 3-engined aircraft the slant distance at the 6500 meter location is greater for certification than for a typical operating procedure initiated at an altitude of 305 meters. However, the third question is different for these two types of procedures and although the factors that determine the answers are basically the same, they are weighted differently in the two procedures.

There are two major segments, the takeoff roll and initial climb that precede initiation of thrust cutback. Both segments are adversely affected by a reduction in density because of an increase in temperature or altitude of the airport. The length of the takeoff roll between start of roll and liftoff is identical for both procedures. It is proportional to the square of the weight divided by the net thrust, less the drag and friction, and also by the lift coefficient times the wing area and other constants. For a given aircraft the takeoff roll is directly proportional to the square of its weight. However, for a series of aircraft designs with the same number of engines but with differing maximum gross weights there is only a small increase in the length of takeoff roll with weight. This small increase appears to be proportional to the 0.2 to 0.25 power of the weight and probably is a significant factor in the choice of the 4 dB per double weight slope (rather than a 3 dB slope) in the FAR Part 36 noise limits. The larger differences in length of takeoff roll usually result from the selection of number of engines. For both types of procedures a shorter takeoff roll is beneficial to the noise; for certification testing enabling attainment of a higher altitude for initiation of cutback prior to the 6500 meter measurement point, and for operational procedures shortening the distances from start of takeoff roll to the altitudes at which cutback can be initiated, which is particularly beneficial for populations residing at distances between approximately 4 and 6.5 km.

The initial climb angle is a direct function of the thrust-weight ratio less the drag-lift ratio, but is limited in some cases by a maximum deck angle for passenger comfort. For certification testing an improvement in the climb angle increases the altitude at which cutback is initiated and thus reduces the noise at the 6500 meter measurement location. However, for the operational procedures initiated at a fixed altitude, improvement in climb angle reduces the distance from the start of takeoff roll to the initiation of cutback, tending to have a lesser effect on the noise at the 6500 meter location than that obtained in the certification test. Thus, for the higher performance aircraft, i.e., those with higher values of thrust-weight ratio and lower values of lift-drag ratio, the EPNL at the 6500 meter location is lower for certification flight procedures than for typical operating flight procedures.

Table 14 summarizes many design factors and the performance areas in which their improvements would be expected to effect. Thrust-weight ratio appears three times, once as a basic factor and twice as a derived factor (engine cycle or selection of fewer engines). It would appear that improvements in any of these design factors, except for engine acoustic treatment, have the potential of improving overall aircraft performance in one or more areas. Additionally, despite the differences in emphasis on first segment performance, it appears that the certification test procedure provides incentives for improvements in the same factors that would be expected to provide improvements in noise during actual flight operations.

TABLE 14 SUMMARY OF SELECTED AIRFRAME-ENGINE DESIGN FACTORS WHICH COULD CONTRIBUTE TO IMPROVEMENTS IN NOISE FOR BOTH CERTIFICATION TEST AND TYPICAL OPERATING PROCEDURES.

DESIGN FACTOR	PERFORMANCE FACTOR IMPROVED			
	Basic Engine Noise	Takeoff Roll	Initial Climb Angle	Thrust Cutback Noise Reduction
Engine:				
Higher bypass ratio	X			
Improved acoustic treatment	X			
Internal engine design noise control	X			
Higher noise reduction per unit thrust cutback				X
Cycle with higher ratio of takeoff thrust to cruise thrust		X	X	X
Airframe and engine:				
Higher thrust-weight ratio		X	X	X
Fewer engines		X	X	X (4 to 3 only)
Lower low speed drag-lift ratio		X	X	X
Lower takeoff drag		X		
Higher takeoof lift (lift coefficient and wing area)		X		

The principal reservation in this conclusion is related to the selection of the number of engines. The FAR Part 36 certification noise limits assume that lower thrust-weight ratios are installed in aircraft which have more engines by allowing higher noise limits for such aircraft. For aircraft weighing more than approximately 106,000 lbs the noise limits for the 6500 meter takeoff position are 2 dB greater for a 4-engined aircraft than for a 3-engined aircraft and 3 dB greater for a 3-engined aircraft than for a 2-engined aircraft.

The interrelationship between noise impact and the FAR Part 36 test and effect of establishing noise limits as a function of number of engines may be partly understood by translating the trial goal of negligible population within NEF 30 into certification limits. For this purpose, we use the hypothetical aircraft previously discussed which had an EPNL of 86.5 at 6500 meters with procedure 3a at an assumed typical weight of 180,000 lbs, and has an assumed maximum gross weight of 220,000 lbs.

Table 15 develops the approximate noise and performance characteristics of this hypothetical aircraft as a function of the number of engines. The estimated values of the length of takeoff roll, thrust-weight ratio and drag-lift ratio are based on the characteristics of aircraft in this study. The cutback noise reduction is estimated on the basis of DC10-10 and B747-200 values, 20 times the logarithm of the thrust ratio, rather than 40 times the logarithm of the thrust ratio which applies to the DC9-10 and -80 and to the B727-100 values used in this study. For certification, thrust cutback was assumed at 6000 meters from start of roll. In practice, the location of cutback would depend on the directivity of the aircraft. The relative EPNL at the altitude over the 6500 meter measurement location was determined from the central curve of

TABLE 15. EXAMPLE OF THE DERIVATION OF APPROXIMATE RELATIONSHIPS BETWEEN FAR PART 36 CERTIFICATION NOISE LEVELS AND THOSE DERIVED FOR A TRIAL GOAL OF NEF 30 WITH NEGLIGIBLE POPULATION (EPNL OF 86.5 dB AT 6500 METERS) FOR A HYPOTHETICAL FLEET AVERAGE AIRCRAFT (TYPICAL WEIGHT OF 180,000 LBS.), FOR PROCEDURE 3a, AS A FUNCTION OF NUMBER OF ENGINES.

	Number of Engines and Aircraft Weight in 1000 lbs.					
	2-engine		3-engine		4-engine	
	180	220	180	220	180	220
Estimated takeoff roll in meters	940	1400	1400	2100	1740	2600
Assumed thrust-weight ratio	.29	.24	.26	.21	.22	.18
Initial climb gradient (drag-lift ratio .09)	.20	.15	.17	.12	.13	.09
Cutback thrust-weight ratio for FAR Part 36 procedure	.62	.75	.52	.64	.59	.72
Climb gradient after cutback	.09	.09	.05	.04	.04	.04
Altitude (meters) at 6500 meters for certification*	--	735	--	490	--	325
Altitude (meters) at 6500 meters for procedure 3a (305 meters)	668	581	470	379	401	325
Distance (meters) to cutback for procedure 3a (305 meters)	2470	3430	3190	4640	4090	5990
Cutback Noise Reduction in dB (high bypass)	-4.1	-2.5	-5.7	-3.9	-5.3	-2.9
Relative EPNL (dB) at 6500 meters (Certification)**	--	-8.3	--	-4.2	--	- .5
Relative EPNL (dB) at 6500 meters (Procedure 3a)**	-7.4	-5.9	-3.9	-2.4	-2.5	- .5
EPNL at 305 meters for Max Thrust & EPNL of 86.5 dB @ 6500 meters for procedure 3a	98.0		96.1		94.3	90.9
Equivalent FAR Part 36 EPNL Derived for Certification test		87.2		88.0		90.9
EPNL at 6500 meters for Pcdr.3a	86.5	89.6	86.5	89.8	86.5	90.9
Equivalent FAR Part 36 EPNL derived for constant technology of 4-engined aircraft		84.7		86.9		
Current FAR Part 36 Stage 3 EPNL Limits		93.5		96.5		98.5

*Assumes cutback at 6000 meters.

**EPNL at altitude minus EPNL at constant distance of 305 meters.

EPNL vs slant distance in Fig. 5. This analysis neglects the differential effects of aircraft velocity and frequency spectra, both of which vary with number of engines. The takeoff velocity of these configurations increases with number of engines producing a small relative reduction in the duration of the noise of a 4-engined aircraft with respect to that of a 2-engined aircraft. On the other hand, the characteristic frequency spectra of the smaller engines on the 4-engined aircraft will register slightly higher per pound of thrust on the perceived noise level scale than will that of the larger engines on the 2-engined aircraft. These two effects are assumed to cancel in this simplified analysis.

The results for this example show that the EPNL of the 2-engined aircraft at maximum thrust could be 3.7 dB greater than that of the 4-engined aircraft when both are measured at a distance of 305 meters. This results primarily from the superior climb performance of the 2-engined aircraft, both before and after cutback. The EPNL for the typical weight aircraft at the 6500 meter measurement location for procedure 3a is 86.5 dB for all three configurations (this was a design constraint), and is approximately 3.5 dB greater when the aircraft is flown at maximum gross weight using procedure 3a.

The FAR Part 36 certification EPNL values, equivalent to the 85.5 dB design constraint, are 87.2, 88.0 and 90.9 dB for the 2-, 3- and 4-engined configurations, respectively. These EPNL noise values have a range of about 4 dB which is comparable to the FAR Part 36 range of 5 dB. If an additional constraint were to be placed on these three configurations, i.e., that all meet the initial 86.5 dB trial goal EPNL value and that, in addition, all employ equal noise control technology — the technology used to achieve the 4-engined aircraft would control the design. In this event, the FAR Part 36 EPNL limits for the 2- and 3-engined aircraft would be lowered by 2.5 and 1.1 dB, respectively. The resulting limits have a range of about 6 dB, again comparable to the FAR Part 36 range of 5 dB. Thus, it appears that, at least for this example, the range of EPNL values with number of engines in the FAR Part 36 Stage 3 noise limits is reasonably consistent with equal impact and technology, at least for procedure 3a.

To attain the 86.5 dB EPNL value of the trial goal the Stage 3 limits of FAR Part 36 would have to be lowered by an amount ranging between 6.3 and 7.6 dB. If both constraints were considered, the limits would have to be lowered by an amount ranging between 7.6 and 9.6 dB. The effect of increasing operations in future years has been ignored in the development of the trial goal of negligible population. Obviously, it should be considered by any future goal, and would be expected to decrease the 86.5 dB EPNL constraint by at least 1.6 dB to 84.9 dB, considering total fleet operations projected in the year 1995 [3, 22], and by a total of approximately 3 dB to 83.5 dB for an even later year when all noisy aircraft were retired.

The methodology in this example can be extended to other trial goals (NEF and population), to other assumed operational takeoff flight procedures, and more precise establishment of a fleet average aircraft size and performance characteristics appropriate to the period for which the goal is ultimately intended.

The concept of "negligible" population vs contour area used in this example can be refined from the average values for 54 airports used here by using the data in references 2, 3 and 21 to subdivide category Y, to better account for the joint probabilities of a high level of operations, noisier than average fleet mix and high population close to some airports. This refinement would result in lower EPNL values for negligible population at a given NEF value, consideration of land use change or soundproofing implications of using average values, or a combination of these two policy approaches.

The results also can be used to improve the basis for policy considerations related to operational flight procedures, and to test procedures, as well as to other factors, and performance requirements which interact with the basic design factors affecting noise and its impact on residential populations.

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APPENDIX A

DETAILED SUMMARY OF RESULTS

This appendix summarizes significant results for the six aircraft at each of two weights and eighteen takeoff procedures. There are 12 data tables, one for each aircraft-weight combination. Data are given as a function of noise level for seven values of EPNL at 5 dB intervals between 85 and 115 dB. For each EPNL value there are 18 values each of:

- Distance to closure
- Area
- Population/runway for the X population density
- Population/runway for the Y population density
- Population/runway for the Z population density
- Airport/runway weighted total population
- Airport/runway level weighted population.

Also given for each procedure are the maximum values of EPNL along a 450 meter sideline and the values of EPNL under the takeoff flight path at distances of 4700, 6500, 9200 and 12,800 meters.

TABLE A-1: DATA SUMMARY FOR DC9-10 AIRCRAFT AT 80,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil)			Airport/Runway Level Weighted Pop. (mil)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	8.80	6.43	8.81	25.0	29.4	34.4	65.6	89.0	124.	10.8	14.5	19.2	4.66	6.07	7.53	8.14	10.3	12.9	0.41	0.49	0.59
	1b Cleanup bef.max C/B	915	17.3	15.8	14.6	44.7	48.7	51.1	191.	227.	243.	28.9	33.2	34.9	8.88	10.7	11.4	14.6	17.2	18.7	0.95	1.07	1.03
	2 Cleanup bef.min C/B	N/A	14.5	14.1	14.3	46.8	48.4	50.6	226.	232.	244.	32.6	33.3	34.9	10.5	11.0	11.2	16.4	17.7	18.7	0.95	1.02	1.04
	3a Max C/B bef.Cleanup	3050	13.6	12.2	10.4	26.0	26.4	28.5	101.	87.8	93.7	14.8	13.3	14.5	4.99	4.85	4.94	8.54	8.46	9.86	0.53	0.47	0.62
	3b Max C/B bef.Cleanup	915	20.3	18.6	16.4	48.6	48.9	50.4	211.	222.	242.	33.2	33.6	35.0	8.85	9.39	10.8	14.9	15.7	17.6	1.02	1.07	1.16
	4 Min C/B bef.Cleanup	N/A	16.6	16.6	16.5	45.6	47.3	49.2	217.	225.	238.	31.1	32.5	34.1	9.90	10.5	11.1	16.0	17.0	18.0	0.95	1.00	1.06
90	1a Cleanup bef.max C/B	3050	6.14	6.39	7.44	15.7	18.7	21.5	22.1	34.3	52.3	4.16	6.10	8.75	2.07	2.85	3.70	3.91	5.32	7.01	0.39	0.46	0.65
	1b Cleanup bef.max C/B	915	13.3	11.7	10.6	18.4	22.0	26.0	44.7	63.7	93.9	7.38	9.80	14.0	2.81	3.80	5.16	5.07	6.91	8.73	0.64	0.77	0.97
	2 Cleanup bef.min C/B	N/A	10.4	10.1	10.2	24.1	24.7	26.1	78.5	80.4	92.7	11.8	12.2	13.8	4.49	4.68	4.72	7.29	7.79	8.67	0.87	0.86	0.92
	3a Max C/B bef.Cleanup	3050	7.04	7.71	6.45	13.7	13.7	16.0	31.8	18.9	22.1	5.09	3.52	4.16	1.99	1.63	1.80	5.79	3.25	3.69	0.48	0.46	0.40
	3b Max C/B bef.Cleanup	915	16.0	14.5	12.17	19.9	20.2	23.2	68.4	67.7	75.3	10.4	10.2	11.0	3.19	3.24	3.91	5.46	5.62	6.60	0.91	0.95	0.96
	4 Min C/B bef.Cleanup	N/A	10.6	10.7	10.4	22.9	24.1	25.0	77.7	85.0	87.3	11.6	12.7	13.0	4.25	4.66	4.85	6.98	7.43	7.85	0.93	0.96	0.97
95	1a Cleanup bef.max C/B	3050	5.08	5.82	6.63	9.84	12.0	13.4	7.94	17.1	24.6	1.59	2.98	4.21	.860	1.46	1.90	1.68	2.78	3.50	0.27	0.51	0.82
	1b Cleanup bef.max C/B	915	5.06	5.91	6.81	9.84	12.0	13.7	7.94	18.3	25.6	1.59	3.18	4.35	.860	1.52	1.96	1.68	2.87	3.69	0.27	0.54	0.88
	2 Cleanup bef.min C/B	N/A	6.72	6.63	7.06	12.1	12.9	13.9	19.1	23.6	29.5	3.30	3.95	4.95	1.52	1.78	1.99	2.69	3.22	3.86	0.57	0.66	0.94
	3a Max C/B bef.Cleanup	3050	6.00	4.92	4.92	6.68	7.14	9.61	4.14	2.13	6.09	.661	.530	1.31	.290	.309	.727	0.80	0.75	1.43	0.20	0.33	0.36
	3b Max C/B bef.Cleanup	915	6.00	4.92	4.92	6.70	7.17	9.73	4.14	2.13	6.09	.661	.530	1.31	.290	.309	.727	0.80	0.75	1.60	0.20	0.33	0.41
	4 Min C/B bef.Cleanup	N/A	6.90	6.99	6.81	11.1	11.7	12.4	18.0	19.4	19.1	3.08	3.35	3.30	1.33	1.45	1.52	2.12	2.41	2.78	0.54	0.64	0.67
100	1a Cleanup bef.max C/B	3050	4.47	5.19	5.37	6.53	7.28	7.18	1.05	4.77	4.77	.248	.812	.812	.142	.408	.408	0.79	1.14	0.97	0.31	0.53	0.47
	1b Cleanup bef.max C/B	915	4.47	5.19	5.37	6.53	7.10	7.20	1.05	4.77	4.77	.248	.812	.812	.142	.408	.408	0.79	1.14	0.97	0.31	0.53	0.47
	2 Cleanup bef.min C/B	N/A	4.92	5.37	5.37	6.92	7.67	7.22	3.84	4.77	4.77	.671	.812	.812	.342	.408	.408	0.87	1.14	0.97	0.36	0.53	0.47
	3a Max C/B bef.Cleanup	3050	4.02	3.21	4.20	3.85	4.40	6.11	.041	-	.124	.036	-	.107	.025	-	.076	0.16	0.02	0.29	0.08	0.01	0.09
	3b Max C/B bef.Cleanup	915	4.02	3.21	4.20	3.85	4.40	6.11	.041	-	.124	.036	-	.107	.025	-	.076	0.16	0.02	0.29	0.08	0.01	0.09
	4 Min C/B bef.Cleanup	N/A	5.10	4.61	4.74	6.0	6.0	6.8	1.90	.970	1.98	.318	.177	.389	.158	.072	.209	0.44	0.36	0.65	0.22	0.17	0.31
105	1a Cleanup bef.max C/B	3050	3.93	3.75	3.48	3.01	2.87	2.74	.041	-	-	.036	-	-	.025	-	-	0.16	0.08	0.01	0.06	0.07	0.01
	1b Cleanup bef.max C/B	915	3.93	3.75	3.48	3.01	2.86	2.74	.041	-	-	.036	-	-	.025	-	-	0.16	0.08	0.01	0.06	0.07	0.01
	2 Cleanup bef.min C/B	N/A	3.93	3.75	3.48	3.05	2.86	2.74	.041	-	-	.036	-	-	.025	-	-	0.16	0.08	0.01	0.06	0.07	0.01
	3a Max C/B bef.Cleanup	3050	2.67	2.67	3.39	1.89	2.13	2.65	-	-	-	-	-	-	-	-	-	0	0	0.02	0	0	0.01
	3b Max C/B bef.Cleanup	915	2.67	2.67	3.39	1.89	2.13	2.65	-	-	-	-	-	-	-	-	-	0	0	0.02	0	0	0.01
	4 Min C/B bef.Cleanup	N/A	3.48	3.21	3.48	2.5	2.7	2.8	-	-	-	-	-	-	-	-	-	0.02	0.02	0.02	0	0.01	0.01
110	1a Cleanup bef.max C/B	3050	2.76	2.45	2.45	1.88	1.77	1.77	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	1b Cleanup bef.max C/B	915	2.76	2.45	2.45	1.88	1.76	1.77	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	2 Cleanup bef.min C/B	N/A	2.76	2.40	2.40	1.88	1.77	1.77	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	3a Max C/B bef.Cleanup	3050	1.95	2.31	2.40	1.48	1.7	1.77	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	3b Max C/B bef.Cleanup	915	1.95	2.13	2.40	1.48	1.7	1.77	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	4 Min C/B bef.Cleanup	N/A	2.45	2.45	2.45	1.8	1.8	1.8	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
115	1a Cleanup bef.max C/B	3050	1.86	1.77	1.77	1.28	1.27	1.27	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	1b Cleanup bef.max C/B	915	1.86	1.77	1.77	1.28	1.27	1.27	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	2 Cleanup bef.min C/B	N/A	1.86	1.77	1.77	1.28	1.27	1.27	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	3a Max C/B bef.Cleanup	3050	1.50	1.77	1.77	1.17	1.27	1.27	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	3b Max C/B bef.Cleanup	915	1.50	1.77	1.77	1.17	1.27	1.27	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
	4 Min C/B bef.Cleanup	N/A	1.77	1.77	1.77	1.3	1.3	1.3	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	105.4	105.4	105.5	97.4	102.2	101.5	89.5	90.6	95.9	84.6	83.5	86.2	80.6	79.1	78.9				1.44	2.06	2.55
	1b Cleanup bef.max C/B	915	105.4	105.4	105.5	97.0	102.2	101.5	89.6	90.9	96.3	87.6	91.9	91.7	90.5	88.7	87.2				2.22	2.99	3.36
	2 Cleanup bef.min C/B	N/A	105.4	105.4	105.5	100.9	102.4	101.5	95.5	95.4	97.0	91.5	91.2	91.4	86.9	86.5	86.6				2.81	3.16	3.01
	3a Max C/B bef.Cleanup	3050	105.4	105.6	105.4	97.9	95.4	95.8	94.1	92.0	90.0	89.7	88.2	86.2	85.6	84.5	82.8				1.35	1.33	1.49
	3b Max C/B bef.Cleanup	915	105.4	105.6	105.4	97.9	95.5	95.8	94.1	92.1	91.0	90.1	90.6	92.8	92.9	91.6	89.4				2.21	2.36	2.96
	4 Min C/B bef.Cleanup	N/A	105.1	105.4	105.4	100.9	99.9	100.3	96.0	95.8	95.4	91.7	91.8	91.6	87.2	87.2	87.0				2.65	2.77	3.03

*A recent update of the Aircraft Noise Data Base (Ref. A-1) indicates that these noise levels are low by 2 dB.

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TABLE A-2: DATA SUMMARY FOR DC9-10 AIRCRAFT AT 90,700 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot.Pop. (mil)			Airport/Runway Level Weighted Pop. (mil)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	11.3	10.8	11.3	31.9	37.2	43.7	117.	153.	204.	17.7	22.6	29.0	6.74	8.30	10.0	5.20	5.89	8.92	.292	.368	.460
	1b Cleanup bef.max C/B	915	19.4	18.2	17.2	52.7	57.3	60.5	225.	275.	306.	34.9	40.7	43.9	10.4	12.4	13.4	12.2	14.3	15.2	.921	1.01	.907
	2 Cleanup bef.min C/B	N/A	16.8	16.9	17.1	56.0	57.5	60.4	268.	287.	306.	38.5	41.6	43.9	11.9	12.8	13.4	14.1	14.6	15.1	.893	.733	.920
	3a Max C/B bef.Cleanup	3050	15.7	14.6	13.0	32.1	33.0	36.3	118.	131.	149.	19.9	19.2	22.0	6.26	6.50	7.02	6.51	6.01	6.36	.423	.428	.447
	3b Max C/B bef.Cleanup	915	22.9	21.6	19.7	57.9	58.0	60.2	234.	248.	281.	37.7	38.9	42.3	9.76	10.7	12.4	13.3	13.7	14.9	.950	.989	1.03
	4 Min C/B bef.Cleanup	N/A	17.3	17.4	17.4	53.4	55.7	58.4	262.	276.	292.	38.0	40.2	42.4	11.4	12.2	12.9	13.6	14.0	14.8	.845	.857	.916
90	1a Cleanup bef.max C/B	3050	8.07	8.14	9.51	19.8	23.3	27.4	58.8	73.1	105.	8.15	11.5	15.5	3.50	4.51	5.62	2.11	3.02	4.17	.214	.257	.374
	1b Cleanup bef.max C/B	915	8.34	13.2	12.4	22.9	27.1	31.7	70.1	102.	138.	11.2	15.5	19.8	4.17	5.47	6.68	3.36	4.53	6.37	.470	.546	.798
	2 Cleanup bef.min C/B	N/A	12.0	12.1	12.3	28.0	29.6	31.7	112.	120.	137.	16.3	17.5	19.6	5.71	6.07	6.65	5.43	5.63	6.09	.705	.683	.727
	3a Max C/B bef.Cleanup	3050	10.5	9.47	8.41	16.5	17.1	19.8	51.2	44.6	46.1	7.49	7.00	7.68	2.68	2.75	3.30	2.35	1.73	1.98	.366	.247	.230
	3b Max C/B bef.Cleanup	915	16.0	14.7	12.9	23.4	26.2	26.8	88.2	88.9	101.	13.0	13.1	14.8	3.89	4.18	5.16	4.39	4.37	4.94	.785	.785	.801
	4 Min C/B bef.Cleanup	N/A	12.5	12.7	12.6	26.8	28.3	29.8	109.	116.	122.	15.8	16.7	17.7	5.39	5.75	6.08	5.26	5.76	5.94	.705	.775	.803
95	1a Cleanup bef.max C/B	3050	6.36	7.35	8.52	12.5	14.9	16.8	19.7	36.0	49.8	3.39	5.89	7.60	1.58	2.43	2.92	0.86	1.51	2.03	.200	.322	.497
	1b Cleanup bef.max C/B	915	6.36	7.35	8.70	12.5	15.0	17.1	19.7	37.3	53.3	3.39	6.10	8.03	1.58	2.50	3.04	0.45	1.60	2.13	.200	.350	.493
	2 Cleanup bef.min C/B	N/A	7.98	8.16	8.88	14.6	15.9	17.3	35.6	44.4	56.4	5.72	6.96	8.45	2.36	2.74	3.16	1.63	1.94	2.30	.386	.461	.594
	3a Max C/B bef.Cleanup	3050	7.17	6.27	6.05	8.49	8.99	11.7	10.1	7.70	15.8	1.69	1.50	2.78	0.72	0.74	1.39	.321	.287	.697	.093	.078	.179
	3b Max C/B bef.Cleanup	915	7.17	6.27	6.00	8.49	8.99	11.9	10.1	7.70	18.4	1.69	1.50	3.18	0.72	0.74	1.52	.321	.287	.697	.092	.078	.179
	4 Min C/B bef.Cleanup	N/A	8.16	8.25	8.16	13.1	13.9	14.9	28.2	31.2	36.9	4.59	5.15	5.92	1.82	2.09	2.42	1.48	1.61	1.63	.322	.462	.428
100	1a Cleanup bef.max C/B	3050	5.64	6.59	6.63	8.27	9.11	8.75	9.79	15.0	12.4	1.58	2.39	1.98	0.74	1.00	0.87	.133	.418	.418	.052	.201	.201
	1b Cleanup bef.max C/B	915	5.64	6.63	6.63	8.27	9.13	8.77	9.79	15.0	12.4	1.58	2.39	1.98	0.74	1.00	0.87	.133	.418	.418	.052	.201	.201
	2 Cleanup bef.min C/B	N/A	6.09	6.72	6.63	8.63	9.22	8.78	11.1	15.0	12.4	1.78	2.39	1.98	0.80	1.00	0.87	.347	.418	.418	.142	.201	.201
	3a Max C/B bef.Cleanup	3050	4.92	4.11	5.10	4.85	5.51	7.49	1.90	0.04	5.70	0.32	0.04	0.10	0.16	0.02	0.47	.024	-	.062	.009	-	.026
	3b Max C/B bef.Cleanup	915	4.92	4.11	5.10	4.85	5.51	7.49	1.90	0.04	5.70	0.32	0.04	0.10	0.16	0.02	0.47	.024	-	.062	.009	-	.026
	4 Min C/B bef.Cleanup	N/A	6.09	5.64	5.82	7.14	7.22	8.22	5.53	4.22	7.94	0.93	0.73	1.30	0.40	0.34	0.61	.196	.092	.204	.079	.044	.096
105	1a Cleanup bef.max C/B	3050	4.92	4.65	4.20	3.82	3.51	3.36	1.90	0.97	0.04	0.32	0.18	0.04	0.16	0.09	0.02	.024	-	-	.014	-	-
	1b Cleanup bef.max C/B	915	4.92	4.65	4.20	3.82	3.51	3.36	1.90	0.97	0.04	0.32	0.18	0.04	0.16	0.09	0.02	.024	-	-	.014	-	-
	2 Cleanup bef.min C/B	N/A	5.01	4.65	4.20	3.85	3.52	3.36	1.90	0.97	0.04	0.32	0.18	0.04	0.16	0.09	0.02	.024	-	-	.014	-	-
	3a Max C/B bef.Cleanup	3050	3.30	3.30	4.20	2.39	2.75	3.33	0	0	0.04	0	0	0.04	0	0	0.02	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	3.30	3.30	4.20	2.40	2.75	3.33	0	0	0.04	0	0	0.04	0	0	0.02	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	4.20	3.93	4.20	3.10	3.19	3.36	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.02	0.02	-	-	-	-	-	-
110	1a Cleanup bef.max C/B	3050	3.39	2.94	2.94	2.29	2.09	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
	1b Cleanup bef.max C/B	915	3.39	2.94	2.94	2.29	2.09	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
	2 Cleanup bef.min C/B	N/A	3.35	2.94	2.94	2.29	2.09	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
	3a Max C/B bef.Cleanup	3050	2.40	2.85	2.94	1.77	2.08	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
	3b Max C/B bef.Cleanup	915	2.40	2.85	2.94	1.77	2.08	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
	4 Min C/B bef.Cleanup	N/A	2.85	2.94	2.94	2.11	2.09	2.09	0	0	0	0	0	0	0	0	0	-	-	-			
115	1a Cleanup bef.max C/B	3050	2.22	2.22	2.22	1.44	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
	1b Cleanup bef.max C/B	915	2.22	2.22	2.22	1.44	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
	2 Cleanup bef.min C/B	N/A	2.22	2.22	2.22	1.44	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
	3a Max C/B bef.Cleanup	3050	1.95	2.22	2.22	1.38	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
	3b Max C/B bef.Cleanup	915	1.95	2.22	2.22	1.38	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
	4 Min C/B bef.Cleanup	N/A	2.22	2.22	2.22	1.44	1.44	1.44	0	0	0	0	0	0	0	0	0	-	-	-			
			Sideline			Takeoff 1 (4700M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,000 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	105.2	105.3	105.3	105.9	104.8	103.7	94.1	100.4	100.2	87.9	87.8	91.2	83.3	82.7	82.6				0.77	1.15	1.53
	1b Cleanup bef.max C/B	915	105.2	105.3	105.3	105.9	104.8	103.7	94.3	100.4	100.2	88.7	89.7	93.8	91.5	90.5	89.6				1.66	2.11	2.40
	2 Cleanup bef.min C/B	N/A	105.2	105.3	105.2	106.0	104.8	103.7	98.5	100.8	100.2	92.9	93.1	94.1	89.1	89.2	89.4				2.14	2.08	2.44
	3a Max C/B bef.Cleanup	3050	104.3	105.1	105.3	100.5	98.4	102.8	96.2	94.5	93.4	91.8	90.4	88.7	87.3	86.6	85.1				0.89	.753	.882
	3b Max C/B bef.Cleanup	915	92.0	105.1	105.3	100.5	98.4	102.8	96.2	94.5	93.6	92.0	91.2	93.3	93.0	91.9	90.1				1.84	1.85	2.04
	4 Min C/B bef.Cleanup	N/A	105.1	105.3	105.3	103.5	102.1	103.6	99.0	98.3	97.7	93.3	93.5	93.4	89.8	89.9	89.8				1.95	2.14	2.24

*A recent update of the Aircraft Noise Data Base (Ref. A-1) indicates that these noise levels are low by 2 dB.

TABLE A-3: DATA SUMMARY FOR DC9-80 AIRCRAFT AT 112,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot.Pop.(mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	8.86	8.34	8.25	17.5	18.8	21.5	45.1	49.6	63.7	7.29	8.04	10.2	3.03	3.37	4.08	3.46	3.83	4.76	.263	.245	.273
	1b Cleanup bef.max C/B	915	9.42	9.20	8.88	17.7	19.9	22.0	46.7	51.4	67.3	7.49	8.26	10.6	3.09	3.43	4.20	3.54	3.92	4.94	.272	.255	.292
	2 Cleanup bef.min C/B	N/A	9.51	9.06	8.88	19.1	20.0	22.1	56.5	57.6	67.3	8.75	9.09	10.6	3.45	3.68	4.20	4.07	4.27	4.94	.306	.291	.292
	3a Max C/B bef.Cleanup	3050	11.0	9.33	7.26	15.8	15.3	16.1	53.9	35.6	31.0	7.76	5.79	5.47	2.68	2.33	2.55	3.45	2.70	2.71	.293	.232	.173
	3b Max C/B bef.Cleanup	915	15.2	13.3	10.2	16.9	15.5	16.4	56.1	38.2	37.8	8.14	6.16	6.29	2.80	2.41	2.76	3.61	2.85	3.05	.309	.250	.209
	4 Min C/B bef.Cleanup	N/A	10.3	9.96	9.24	19.0	19.4	20.3	61.3	56.3	59.3	9.09	8.68	9.29	3.40	3.37	3.73	4.16	4.02	4.35	.309	.305	.300
90	1a Cleanup bef.max C/B	3050	5.69	5.82	6.77	9.06	10.5	12.2	6.39	13.8	23.6	1.30	2.43	3.92	.675	1.21	1.73	.671	1.24	1.90	.087	.172	.294
	1b Cleanup bef.max C/B	915	5.69	5.82	6.77	9.09	10.5	12.3	6.39	13.8	23.6	1.30	2.43	3.92	.675	1.21	1.73	.671	1.24	1.90	.087	.172	.294
	2 Cleanup bef.min C/B	N/A	6.09	5.96	6.81	9.67	10.7	12.3	9.56	13.8	23.6	1.78	2.43	3.92	.873	1.21	1.73	.899	1.24	1.90	.128	.172	.294
	3a Max C/B bef.Cleanup	3050	6.59	5.01	5.10	6.80	7.07	9.38	6.76	2.05	7.87	1.07	.459	1.52	.420	.259	.809	.496	.246	.797	.088	.038	.107
	3b Max C/B bef.Cleanup	915	6.59	5.06	5.06	6.98	7.09	9.40	6.76	2.05	7.87	1.07	.459	1.52	.420	.259	.809	.496	.246	.797	.088	.038	.107
	4 Min C/B bef.Cleanup	N/A	6.86	6.45	5.91	9.32	9.49	10.6	12.5	9.48	13.8	2.05	1.71	2.43	.919	.822	1.21	1.00	.858	1.24	.145	.140	.172
95	1a Cleanup bef.max C/B	3050	4.29	4.92	5.10	5.20	5.82	5.83	1.05	1.98	1.98	.248	.389	.389	.142	.209	.209	1.33	.205	.205	.037	.058	.058
	1b Cleanup bef.max C/B	915	4.29	4.92	5.01	5.20	5.82	5.75	1.05	1.98	1.98	.248	.389	.389	.142	.209	.209	1.33	.205	.205	.037	.058	.058
	2 Cleanup bef.min C/B	N/A	4.47	5.01	4.83	5.25	5.83	5.75	1.05	1.98	1.98	.248	.389	.389	.142	.209	.209	1.33	.205	.205	.037	.058	.058
	3a Max C/B bef.Cleanup	3050	3.75	3.39	4.47	3.12	3.92	5.27	--	--	1.05	--	--	.248	--	--	.142	--	--	.338	--	--	.037
	3b Max C/B bef.Cleanup	915	3.75	3.35	4.47	3.21	3.92	5.27	--	--	1.05	--	--	.248	--	--	.142	--	--	.338	--	--	.037
	4 Min C/B bef.Cleanup	N/A	4.83	4.11	4.74	4.50	4.75	5.56	1.90	.041	1.98	.318	.036	.389	.158	.025	.209	.163	.021	.204	.048	.005	.058
100	1a Cleanup bef.max C/B	3050	3.75	3.66	3.48	2.75	2.55	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.75	3.66	3.48	2.75	2.55	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.75	3.66	3.48	2.75	2.55	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.40	3.03	3.39	1.93	2.27	2.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.45	3.03	3.39	1.93	2.27	2.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.99	3.30	3.39	2.27	2.47	2.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
105	1a Cleanup bef.max C/B	3050	2.76	2.58	2.58	1.96	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	2.76	2.58	2.58	1.96	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	2.76	2.58	2.58	1.96	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.22	2.49	2.58	1.69	1.89	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.22	2.49	2.58	1.72	1.89	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.58	2.58	2.91	1.90	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110	1a Cleanup bef.max C/B	3050	1.95	1.95	1.95	1.05	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	1.95	1.95	1.95	1.05	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	1.95	1.95	1.95	1.05	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	1.86	1.95	1.95	.985	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	1.95	1.95	1.95	1.05	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	1.95	1.91	1.95	1.05	1.05	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	1a Cleanup bef.max C/B	3050	1.59	1.64	1.59	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	1.59	1.59	1.59	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	1.59	1.59	1.59	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	.513	1.59	1.59	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	1.59	1.59	1.59	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	1.55	1.59	1.64	.162	.162	.162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	99.5	99.5	99.5	92.7	96.3	95.9	88.4	87.9	91.1	84.6	83.9	83.5	80.9	80.5	79.8				.387	.475	.625
	1b Cleanup bef.max C/B	915	99.5	99.5	99.5	92.7	96.3	95.7	88.4	88.0	91.1	85.1	85.0	84.6	83.2	82.4	81.3				.396	.485	.644
	2 Cleanup bef.min C/B	N/A	99.5	99.5	99.5	93.7	96.4	95.5	89.3	88.7	91.2	85.3	84.9	84.6	82.5	82.0	81.3				.471	.521	.644
	3a Max C/B bef.Cleanup	3050	99.5	99.5	99.5	93.0	90.6	92.8	90.1	88.1	85.9	86.8	85.1	83.1	82.2	82.1	80.6				.381	.270	.317
	3b Max C/B bef.Cleanup	915	99.5	99.5	99.5	93.0	90.6	92.8	90.1	88.1	86.0	86.8	85.2	85.2	84.0	85.1	83.2				.397	.288	.353
	4 Min C/B bef.Cleanup	N/A	99.5	99.5	99.5	95.3	93.2	95.2	90.9	89.8	88.5	86.2	85.7	85.0	83.3	83.0	82.3				.502	.450	.530

TABLE A-4: DATA SUMMARY FOR DC9-80 AIRCRAFT AT 140,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	13.0	12.2	11.6	25.8	26.8	29.4	109.	114.	139.	15.9	16.5	19.6	5.49	5.72	6.57	7.06	7.35	8.64	.458	.424	.467
	1b Cleanup bef.max C/B	915	13.2	12.5	11.9	25.9	26.9	29.6	109.	115.	136.	15.9	16.6	19.2	5.49	5.76	6.48	7.06	7.40	8.49	.455	.428	.450
	2 Cleanup bef.min C/B	N/A	13.2	12.5	11.9	25.9	26.9	29.6	109.	115.	136.	15.9	16.6	19.2	5.49	5.76	6.48	7.06	7.40	8.49	.455	.428	.450
	3a Max C/B bef.Cleanup	3050	14.9	11.8	11.8	24.1	24.0	21.7	98.0	98.4	84.8	14.0	14.3	12.4	4.43	4.84	4.43	6.03	6.31	5.58	.427	.469	.417
	3b Max C/B bef.Cleanup	915	16.8	15.1	12.7	25.0	25.9	22.3	102.	110.	87.5	14.8	16.0	12.8	4.59	5.31	4.52	6.32	7.00	5.73	.459	.515	.434
	4 Min C/B bef.Cleanup	N/A	14.3	13.1	12.5	25.5	26.3	27.1	110.	114.	118.	16.0	16.5	17.0	5.24	5.57	5.89	6.97	7.17	7.57	.474	.469	.446
90	1a Cleanup bef.max C/B	3050	8.48	8.21	9.47	13.0	14.4	16.6	36.6	44.3	61.5	5.39	6.82	8.94	2.19	2.64	3.23	2.54	3.15	4.04	.299	.350	.527
	1b Cleanup bef.max C/B	915	8.52	8.21	9.47	13.0	14.4	16.6	36.6	44.3	61.5	5.39	6.82	8.94	2.19	2.64	3.23	2.56	3.15	4.04	.299	.350	.527
	2 Cleanup bef.min C/B	N/A	8.52	8.21	9.47	13.0	14.4	16.6	36.6	44.3	61.5	5.39	6.82	8.94	2.19	2.64	3.23	2.56	3.15	4.04	.299	.350	.527
	3a Max C/B bef.Cleanup	3050	9.47	8.25	6.81	10.9	10.8	10.3	27.9	22.0	17.1	4.13	3.52	2.88	1.54	1.47	1.28	1.89	1.67	1.40	.288	.236	.183
	3b Max C/B bef.Cleanup	915	9.47	8.66	6.81	10.9	11.6	10.3	27.9	26.4	17.1	4.13	4.14	2.89	1.54	1.66	1.28	1.89	1.94	1.40	.287	.275	.184
	4 Min C/B bef.Cleanup	N/A	9.24	8.83	8.12	12.2	13.0	14.5	33.3	37.1	44.3	5.08	5.69	6.82	1.90	2.16	2.64	2.32	2.61	3.15	.342	.331	.366
95	1a Cleanup bef.max C/B	3050	6.18	7.08	6.99	6.99	7.68	7.44	11.1	16.4	16.4	1.78	2.59	2.59	.804	1.06	1.06	.877	1.22	1.22	.196	.332	.332
	1b Cleanup bef.max C/B	915	6.18	7.04	6.99	6.99	7.68	7.44	11.1	16.4	16.4	1.78	2.59	2.59	.804	1.06	1.06	.877	1.22	1.22	.196	.332	.332
	2 Cleanup bef.min C/B	N/A	6.18	7.04	6.99	6.99	7.68	7.44	11.1	16.4	16.4	1.78	2.59	2.59	.804	1.06	1.06	.877	1.22	1.22	.196	.332	.332
	3a Max C/B bef.Cleanup	3050	5.91	5.10	5.15	4.89	5.41	5.47	4.16	3.84	3.84	.661	.671	.671	.290	.342	.342	.321	.347	.347	.098	.074	.074
	3b Max C/B bef.Cleanup	915	5.91	5.37	5.15	4.89	5.54	5.47	4.16	4.77	3.84	.661	.812	.671	.290	.408	.342	.321	.418	.347	.098	.096	.074
	4 Min C/B bef.Cleanup	N/A	6.27	5.87	6.81	5.86	5.90	7.30	5.54	10.4	15.0	.935	1.68	2.39	.405	.710	.999	.450	.803	1.14	.132	.199	.303
100	1a Cleanup bef.max C/B	3050	5.37	5.10	4.92	3.88	3.55	3.50	2.83	1.90	1.90	.459	.318	.318	.225	.158	.158	.235	.163	.163	.105	.079	.079
	1b Cleanup bef.max C/B	915	5.37	5.15	4.92	3.88	3.55	3.50	2.83	1.90	1.90	.459	.318	.318	.225	.158	.158	.235	.163	.163	.105	.079	.079
	2 Cleanup bef.min C/B	N/A	5.37	5.15	4.92	3.88	3.55	3.50	2.83	1.90	1.90	.459	.318	.318	.225	.158	.158	.235	.163	.163	.105	.079	.079
	3a Max C/B bef.Cleanup	3050	3.75	4.38	4.38	2.75	3.25	3.25	-	.970	.970	-	.177	.177	-	.092	.092	-	.255	.092	-	.044	.044
	3b Max C/B bef.Cleanup	915	3.75	4.38	4.38	2.75	3.25	3.25	-	.970	.970	-	.177	.177	-	.092	.092	-	.255	.092	-	.044	.044
	4 Min C/B bef.Cleanup	N/A	4.25	4.83	4.92	3.20	3.48	3.50	.041	1.90	1.90	.036	.318	.318	.025	.158	.158	.024	.163	.163	.069	.079	.079
105	1a Cleanup bef.max C/B	3050	3.93	3.66	3.66	2.75	2.66	2.66	.041	-	-	.036	-	-	.025	-	-	.021	-	-	.014	-	-
	1b Cleanup bef.max C/B	915	3.93	3.66	3.66	2.75	2.66	2.66	.041	-	-	.036	-	-	.025	-	-	.021	-	-	.014	-	-
	2 Cleanup bef.minC/B	N/A	3.93	3.66	3.66	2.75	2.66	2.66	.041	-	-	.036	-	-	.025	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	3.35	3.66	3.66	2.50	2.66	2.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	3.30	3.66	3.66	2.50	2.66	2.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.80	3.66	3.66	2.70	2.66	2.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110	1a Cleanup bef.max C/B	3050	3.03	3.03	3.03	1.19	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.03	3.03	3.03	1.19	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.03	3.03	3.03	1.19	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.94	3.03	3.03	1.18	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b max C/B bef.Cleanup	915	2.94	3.03	3.03	1.18	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.94	3.03	3.26	1.18	1.19	1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	1a Cleanup bef.max C/B	3050	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
	1b Cleanup bef.max C/B	915	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
	2 Cleanup bef.min C/B	N/A	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
	3a Max C/B bef.Cleanup	3050	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
	3b Max C/B bef.Cleanup	915	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
	4 Min C/B bef.Cleanup	N/A	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-						
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	100.0	100.0	100.0	102.6	101.0	100.6	93.7	96.9	95.8	89.1	88.3	91.1	85.2	84.6	83.8				1.07	1.19	1.41
	1b Cleanup bef.max C/B	915	100.0	100.0	100.0	102.6	101.0	100.6	93.7	96.9	95.8	89.1	88.3	91.1	85.3	84.8	84.3				1.07	1.19	1.39
	2 Cleanup bef.max C/B	N/A	100.0	100.0	100.0	102.6	101.0	100.6	93.7	96.9	95.8	89.1	88.3	91.1	85.3	84.8	84.3				1.07	1.19	1.39
	3a Max C/B bef.Cleanup	3050	100.0	100.0	100.0	97.5	96.4	96.6	94.0	92.2	90.6	90.3	88.9	87.1	86.6	85.7	84.4				.813	.823	.718
	3b Max C/B bef.Cleanup	915	100.0	100.0	100.0	97.5	96.9	96.6	94.0	92.9	90.6	90.3	89.4	87.1	86.6	85.9	84.9				.844	.930	.736
	4 Min C/B bef.Cleanup	N/A	100.0	100.0	100.0	98.3	100.8	100.6	94.5	92.9	95.6	90.0	89.0	87.9	85.9	85.4	84.8				.957	1.08	1.19

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TABLE A-5: DATA SUMMARY FOR B727-100 AIRCRAFT AT 135,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	14.7	12.8	12.2	39.6	46.1	53.5	166.	198.	276.	24.8	28.9	38.7	8.73	10.3	12.9	11.1	12.9	17.0	.585	.623	.735
	1b Cleanup bef.max C/B	915	27.6	23.7	20.0	71.3	75.5	79.9	240.	300.	409.	62.3	49.2	60.1	11.7	14.2	17.4	16.9	20.2	24.9	.638	1.23	1.28
	2 Cleanup bef.min C/B	N/A	19.3	20.8	19.8	69.7	74.6	79.4	343.	377.	412.	50.7	55.6	60.0	14.8	16.4	17.5	18.4	20.9	25.0	1.13	1.24	1.27
	3a Max C/B bef.Cleanup	3050	24.2	20.6	15.2	42.9	40.7	39.9	161.	158.	168.	25.4	24.6	25.1	7.21	7.76	8.90	10.4	10.4	11.2	.502	.600	.673
	3b Max C/B bef.Cleanup	915	35.8	31.7	25.8	86.5	84.2	82.3	199.	216.	311.	37.7	41.2	52.7	8.73	10.2	14.3	12.5	15.7	18.5	.790	.973	1.36
	4 Min C/B bef.Cleanup	N/A	19.8	19.9	19.9	69.6	72.9	76.6	346.	358.	383.	51.5	53.4	57.0	16.9	15.4	16.6	21.4	22.1	23.7	1.15	1.18	1.26
90	1a Cleanup bef.max C/B	3050	9.87	9.06	9.92	23.6	27.2	36.5	71.9	95.1	154.	11.3	14.7	21.9	4.57	5.67	7.67	5.30	6.78	9.81	.516	.633	.897
	1b Cleanup bef.max C/B	915	[illegible]	[illegible]	14.6	30.7	34.4	42.7	88.4	121.	210.	15.3	19.5	29.7	5.27	6.63	9.48	6.66	8.51	12.9	.797	.982	1.43
	2 Cleanup bef.min C/B	N/A	14.2	14.2	14.4	36.5	39.2	42.6	167	184	212	24.0	26.3	29.9	7.90	8.58	9.55	10.5	11.5	12.9	1.27	1.33	1.39
	3a Max C/B bef.Cleanup	3050	16.7	13.6	8.39	23.4	21.1	22.1	91.2	68.7	58.8	13.2	10.2	9.62	4.02	3.66	4.09	5.60	4.60	4.60	.799	.662	.478
	3b Max C/B bef.Cleanup	915	[illegible]	[illegible]	[illegible]	36.6	34.4	35.4	105	92.5	121.	17.5	16.8	20.2	4.58	4.72	6.24	6.92	6.74	8.46	1.09	1.14	1.28
	4 Min C/B bef.Cleanup	N/A	14.6	14.7	14.8	36.4	37.8	40.2	169.	176.	109.	24.2	25.3	27.1	7.63	8.07	8.72	10.4	10.9	11.7	1.26	1.19	1.38
95	1a Cleanup bef.max C/B	3050	6.99	7.62	9.42	14.5	17.3	21.4	29.4	42.9	76.7	4.88	7.07	11.3	2.11	2.91	4.21	2.35	3.33	5.17	.423	.520	1.01
	1b Cleanup bef.max C/B	915	6.99	7.62	10.1	14.5	17.3	22.0	29.4	43.8	83.5	4.98	7.21	12.2	2.11	2.97	4.40	2.37	3.39	5.51	.433	.540	1.42
	2 Cleanup bef.min C/B	N/A	9.51	9.69	10.2	18.2	20.2	22.5	56.8	69.4	90.4	8.45	10.4	12.9	3.15	3.87	4.62	3.86	4.74	5.83	1.10	.974	1.25
	3a Max C/B bef.Cleanup	3050	11.2	7.71	6.27	11.2	10.8	13.7	23.3	12.2	21.8	3.36	2.19	3.85	1.13	.980	1.84	1.48	1.06	1.93	.271	.293	.352
	3b Max C/B bef.Cleanup	915	11.2	7.71	7.62	11.2	10.8	13.7	23.3	12.2	21.8	3.36	2.19	3.88	1.13	.980	1.87	1.48	1.06	1.95	.271	.293	.357
	4 Min C/B bef.Cleanup	N/A	10.1	10.0	10.2	18.1	18.7	19.8	59.4	62.0	68.4	8.68	9.08	10.2	3.19	3.32	3.79	3.95	4.12	4.65	.877	.914	1.12
100	1a Cleanup bef.max C/B	3050	6.05	6.99	8.16	9.46	10.9	11.7	12.4	21.7	27.9	1.98	3.51	4.41	.869	1.40	1.70	.963	1.63	2.03	.280	.658	.951
	1b Cleanup bef.max C/B	915	6.05	6.99	8.16	9.46	10.9	11.8	12.4	21.7	27.9	1.98	3.51	4.38	.869	1.40	1.67	.963	1.63	2.01	.280	.658	.944
	2 Cleanup bef.min C/B	N/A	6.95	7.44	8.25	10.1	11.4	11.8	15.0	23.5	27.9	2.39	3.72	4.38	.999	1.46	1.67	1.14	1.72	2.01	.327	.661	.734
	3a Max C/B bef.Cleanup	3050	7.44	4.47	5.60	6.79	6.22	8.71	9.86	.970	8.56	1.48	.177	1.45	.544	.092	.724	.672	.092	.745	.273	.097	.280
	3b Max C/B bef.Cleanup	915	8.79	4.47	5.60	6.79	6.22	8.71	9.86	.970	8.56	1.48	.177	1.45	.544	.092	.724	.672	.092	.745	.273	.044	.280
	4 Min C/B bef.Cleanup	N/A	7.53	7.44	6.63	9.99	9.69	10.0	20.8	18.1	15.2	3.21	2.81	2.53	1.25	1.12	1.10	.839	1.31	1.09	.606	.595	.514
105	1a Cleanup bef.max C/B	3050	5.60	6.00	5.10	5.68	5.58	5.04	4.77	4.22	1.98	.812	.732	.389	.408	.340	.209	.418	.363	.205	.244	.275	.149
	1b Cleanup bef.max C/B	915	5.60	6.41	5.10	5.68	5.58	5.07	4.77	4.22	1.98	.812	.732	.389	.408	.340	.209	.418	.363	.205	.243	.275	.149
	2 Cleanup bef.min C/B	N/A	5.73	6.09	5.10	5.76	5.58	5.04	6.08	5.54	1.98	1.02	.935	.389	.473	.405	.209	.506	.449	.205	.317	.220	.149
	3a Max C/B bef.Cleanup	3050	4.74	3.57	4.83	3.36	3.59	4.87	1.90	-	1.90	.318	-	.318	.158	-	.158	.163	-	.163	.122	-	.122
	3b Max C/B bef.Cleanup	915	4.74	3.57	4.83	3.36	3.59	4.81	1.90	-	1.90	.318	-	.318	.158	-	.158	.163	-	.163	.122	-	.122
	4 Min C/B bef.Cleanup	N/A	5.73	4.74	5.15	4.78	4.58	4.96	4.14	1.09	1.98	.661	.318	.389	.290	.158	.209	.321	.133	.313	.248	.122	.149
110	1a Cleanup bef.max C/B	3050	4.47	3.66	3.57	2.99	2.55	2.54	.970	-	-	.177	-	-	.092	-	-	.092	-	-	.100	-	-
	1b Cleanup bef.max C/B	915	4.47	3.66	3.57	2.99	2.55	2.54	.970	-	-	.177	-	-	.092	-	-	.092	-	-	.100	-	-
	2 Cleanup bef.min C/B	N/A	4.47	3.66	3.57	2.99	2.55	2.54	.970	-	-	.177	-	-	.092	-	-	.092	-	-	.100	-	-
	3a Max C/B bef.Cleanup	3050	2.85	3.21	3.57	2.05	2.38	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.85	3.21	3.57	2.05	2.38	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.75	3.57	3.57	2.57	2.56	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	1a Cleanup bef.max C/B	3050	2.76	2.58	2.58	1.93	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	2.76	2.58	2.58	1.93	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	2.76	2.58	2.58	1.93	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.31	2.58	2.58	1.78	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.76	2.58	2.58	1.78	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.67	2.58	2.58	1.92	1.90	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	107.2	107.2	107.3	109.5	107.6	106.2	96.7	103.4	102.6	91.0	89.7	96.1	86.7	85.0	84.0				2.16	3.33	3.74
	1b Cleanup bef.max C/B	915	107.2	107.2	107.3	109.5	107.6	106.2	96.7	103.4	102.6	91.1	89.8	96.9	87.2	89.0	92.3				2.39	3.69	5.22
	2 Cleanup bef.min C/B	N/A	107.2	107.2	107.3	104.5	107.6	106.2	98.4	103.9	102.6	94.2	95.8	97.6	91.6	91.7	91.9				4.25	4.43	4.79
	3a Max C/B bef.Cleanup	3050	107.8	107.8	107.8	105.2	99.5	105.6	101.5	96.7	93.8	97.4	93.6	89.0	93.5	90.2	86.3				1.97	1.65	1.91
	3b Max C/B bef.Cleanup	915	105.1	107.8	107.8	105.2	99.5	105.6	101.5	96.7	93.6	97.4	93.6	89.6	93.5	90.3	94.6				2.55	2.45	3.38
	4 Min C/B bef.Cleanup	N/A	107.0	107.2	107.3	107.4	105.1	106.1	103.1	101.7	100.2	96.3	96.4	96.2	92.3	92.3	92.5				4.14	4.00	4.23

TABLE A-6: DATA SUMMARY FOR B727-100 AIRCRAFT AT 160,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	18.7	16.9	15.9	54.3	60.6	70.2	272.	330.	392.	39.1	46.1	54.6	12.1	14.2	16.1	16.7	19.7	23.0	.705	.838	.892
	1b Cleanup bef.max C/B	915	30.1	28.1	24.7	87.9	94.4	99.8	319.	392.	481.	52.4	62.4	73.4	14.1	16.8	19.6	20.9	25.0	29.5	1.00	1.29	1.64
	2 Cleanup bef.min C/B	N/A	24.9	24.7	24.7	90.2	96.0	100.	406.	456.	481.	63.0	69.7	73.3	17.0	18.8	19.6	25.4	28.1	29.5	1.15	1.31	1.58
	3a Max C/B bef.Cleanup	3050	36.1	33.7	29.2	71.0	70.3	69.0	229.	249.	294.	38.7	40.8	45.5	10.0	11.3	13.3	15.2	16.5	18.9	.815	.904	1.06
	3b Max C/B bef.Cleanup	915	38.9	36.6	32.1	109.	104.	107.	271.	293.	372.	51.5	54.0	64.0	11.8	13.2	16.4	19.2	20.6	25.0	1.06	1.11	1.31
	4 Min C/B bef.Cleanup	N/A	24.1	24.1	23.9	81.8	86.8	88.8	378.	406.	433.	58.8	62.8	65.8	15.8	17.0	18.0	23.7	25.3	26.7	1.23	1.26	1.38
90	1a Cleanup bef.max C/B	3050	13.0	12.4	13.7	34.0	38.1	45.3	159.	191.	244.	22.6	26.7	33.9	7.59	8.72	10.4	9.96	11.7	7.37	.896	.951	1.31
	1b Cleanup bef.max C/B	915	23.8/ 13.7	21.8/ 12.6	18.9	41.4	45.8	54.6	170.	209.	284.	25.9	31.0	40.9	8.12	9.47	11.8	11.0	13.1	17.0	1.13	1.26	1.68
	2 Cleanup bef.min C/B	N/A	18.5	16.1	18.2	49.4	52.0	55.0	240.	265.	285.	35.0	38.1	40.7	10.3	11.2	11.8	14.7	15.9	16.9	1.57	1.60	1.63
	3a Max C/B bef.Cleanup	3050	20.4	18.1	13.6	33.0	32.0	32.2	121.	126.	138.	18.5	18.6	20.0	5.32	5.90	6.93	7.63	7.99	8.90	.698	.991	.890
	3b Max C/B bef.Cleanup	915	32.0	29.5	25.0	51.2	46.3	51.0	141.	151.	190.	24.5	26.2	31.8	6.16	7.00	9.06	9.51	10.4	12.9	1.64	1.49	1.71
	4 Min C/B bef.Cleanup	N/A	16.9	17.8	16.7	41.4	45.5	45.4	202.	222.	229.	29.0	32.2	32.6	8.67	9.64	9.97	12.2	13.6	13.9	1.32	1.54	1.45
95	1a Cleanup bef.max C/B	3050	10.1	10.6	12.8	21.2	24.3	27.9	81.6	109.	130.	11.7	15.1	18.0	4.16	5.12	5.51	5.27	6.70	7.69	.841	1.12	1.46
	1b Cleanup bef.max C/B	915	10.1	10.8	13.3	21.2	24.4	29.3	81.6	109.	142.	11.7	15.1	19.9	4.16	5.16	6.30	5.27	6.72	8.44	.841	1.12	1.61
	2 Cleanup bef.min C/B	N/A	13.2	13.2	13.7	26.4	28.0	30.2	109.	130.	145.	15.4	18.1	20.3	4.99	5.87	6.38	6.70	7.89	8.75	1.33	1.45	1.73
	3a Max C/B bef.Cleanup	3050	14.0	11.4	8.46	17.0	16.0	19.0	61.5	42.4	60.5	8.70	6.34	9.19	2.80	2.37	3.53	3.78	2.90	4.24	.945	.674	.749
	3b Max C/B bef.Cleanup	915	23.9 14.0	21.6 11.4	17.17 [illegible]	16.9	16.3	19.0	62.2	43.5	62.5	8.93	6.64	9.63	2.83	2.42	3.61	3.85	3.00	4.39	.968	.711	.777
	4 Min C/B bef.Cleanup	N/A	11.9	12.1	11.8	21.4	22.2	23.8	88.9	92.5	104.	12.6	13.0	14.7	4.18	4.30	5.03	5.53	5.71	6.53	1.08	1.21	1.31
100	1a Cleanup bef.max C/B	3050	8.88	10.1	10.0	13.9	15.7	15.3	42.0	53.4	56.9	5.95	7.44	7.81	2.05	2.53	2.53	2.65	3.30	3.41	.544	1.09	1.44
	1b Cleanup bef.max C/B	915	8.88	10.1	11.2	13.9	15.7	16.0	42.0	53.4	62.3	5.95	7.44	8.64	2.05	2.53	2.87	2.65	3.30	3.81	.544	1.09	1.64
	2 Cleanup bef.min C/B	N/A	7.85	10.4	11.1	15.2	16.4	16.0	43.5	58.5	58.9	6.13	8.05	8.23	2.09	2.68	2.77	2.72	3.55	3.64	.734	1.23	1.54
	3a Max C/B bef.Cleanup	3050	9.15	6.54	7.35	10.0	9.00	12.1	15.2	10.6	25.3	2.13	1.70	4.10	.724	.736	1.60	.945	.821	1.89	.298	.315	.561
	3b Max C/B bef.Cleanup	915	9.15	6.54	7.44	10.0	9.00	12.2	15.2	10.6	27.1	2.13	1.70	4.27	.724	.736	1.66	.945	.821	1.97	.298	.316	.605
	4 Min C/B bef.Cleanup	N/A	9.06	9.06	8.61	12.0	12.1	13.2	34.9	31.3	38.7	5.10	4.67	5.70	1.81	1.69	2.08	2.29	2.11	2.58	.892	.743	.945
105	1a Cleanup bef.max C/B	3050	8.34	8.43	6.81	8.22	7.56	6.31	24.3	19.1	10.6	3.64	2.83	1.70	1.37	1.11	.736	1.67	1.32	.821	1.01	.926	.567
	1b Cleanup bef.max C/B	915	8.34	8.43	6.95	8.22	7.60	6.64	24.3	19.1	10.6	3.64	2.83	1.70	1.37	1.11	.736	1.67	1.32	.821	1.01	.925	.513
	2 Cleanup bef.min C/B	N/A	7.83	8.41	6.95	9.00	8.00	7.00	19.4	19.7	10.6	3.01	2.83	1.70	1.19	1.11	.736	1.40	1.33	.821	.788	.931	.513
	3a Max C/B bef.Cleanup	3050	6.09	4.82	6.54	5.00	5.30	7.00	5.45	1.98	10.6	.864	.389	1.70	.355	.209	.736	.408	.204	.821	.306	.068	.513
	3b Max C/B bef.Cleanup	915	6.09	4.83	6.61	5.00	5.20	7.00	5.45	1.98	10.6	.864	.389	1.70	.355	.209	.736	.408	.204	.821	.306	.081	.513
	4 Min C/B bef.Cleanup	N/A	7.26	6.27	6.81	6.20	6.10	6.60	8.16	9.25	10.6	1.34	1.50	1.70	.535	.671	.736	.356	.734	.821	.368	.442	.513
110	1a Cleanup bef.max C/B	3050	6.36	4.92	4.70	4.17	3.39	3.24	5.45	1.90	.970	.864	.318	.177	.355	.158	.092	.408	.163	.092	.447	.179	.100
	1b Cleanup bef.max C/B	915	6.36	4.92	4.74	4.17	3.39	3.40	5.45	1.90	1.90	.864	.318	.318	.355	.158	.158	.408	.408	.149	.447	.179	.179
	2 Cleanup bef.min C/B	N/A	6.81	4.92	4.74	4.20	3.40	3.30	5.45	1.90	1.90	.864	.318	.318	.355	.158	.158	.408	.408	.133	.447	.179	.179
	3a Max C/B bef.Cleanup	3050	4.02	4.38	4.74	3.00	3.30	3.40	.041	.970	1.90	.036	.177	.318	.025	.158	.158	.026	.125	.133	.020	.121	.179
	3b Max C/B bef.Cleanup	915	4.02	4.34	4.81	3.00	3.30	3.40	.041	.970	1.90	.036	.177	.318	.025	.092	.158	.026	.092	.133	.020	.100	.179
	4 Min C/B bef.Cleanup	N/A	5.15	4.83	4.74	3.44	3.40	3.36	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.133	.163	.163	.179	.179	.179
115	1a Cleanup bef.max C/B	3050	3.84	3.57	3.48	2.60	2.54	2.50	.041	-	-	.036	-	-	.025	-	-	.842	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.84	3.57	3.57	2.61	2.54	2.54	.041	-	-	.036	-	-	.025	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.82	3.57	3.57	3.00	3.00	3.00	.041	-	-	.036	-	-	.025	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	3.21	3.57	3.57	2.40	3.00	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	3.21	3.57	3.57	2.40	3.00	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.66	3.57	3.57	2.58	2.50	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	107.1	107.1	106.9	113.1	110.4	109.7	109.7	107.5	105.6	97.6	103.8	102.0	90.7	89.3	94.8				4.68	5.10	5.77
	1b Cleanup bef.max C/B	915	107.1	108.3	108.3	113.1	110.4	110.2	109.7	107.5	105.7	97.6	103.8	102.3	90.8	89.7	96.0				4.97	5.86	7.26
	2 Cleanup bef.min C/B	N/A	107.1	107.1	107.1	113.1	110.4	110.2	109.4	107.5	105.7	101.9	104.0	102.0	95.5	95.4	96.8				6.02	6.70	7.17
	3a Max C/B bef.Cleanup	3050	106.8	107.1	107.1	108.0	105.7	110.2	104.3	100.0	105.3	100.0	97.0	93.7	96.1	93.8	90.5				2.38	3.07	3.95
	3b Max C/B bef.Cleanup	915	106.8	107.1	107.1	108.0	105.7	110.3	104.3	100.0	105.6	100.0	97.0	93.7	96.1	93.8	90.9				2.65	3.81	5.09
	4 Min C/B bef.Cleanup	N/A	107.0	107.1	107.1	110.9	110.3	110.2	106.9	104.6	105.7	99.7	99.7	98.6	94.0	94.4	93.8				5.07	5.37	5.78

TABLE A-7; DATA SUMMARY FOR DC10-10 AIRCRAFT AT 370,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
	Initiation Altitude		122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	14.4	13.6	14.6	29.2	29.8	32.7	140.	145.	162.	19.9	20.4	22.9	6.41	6.60	7.15	8.64	8.88	9.83	.565	.534	.597
	1b Cleanup bef.max C/B	915	16.6	15.1	14.7	32.2	31.9	32.1	155.	156.	158.	22.3	22.1	22.2	6.92	6.97	6.99	9.53	9.52	9.57	.655	.605	.614
	2 Cleanup bef.min C/B	N/A	14.6	14.3	14.2	30.8	31.3	31.6	150.	154.	154.	21.1	22.0	22.0	6.70	6.89	6.88	9.12	9.44	9.44	.581	.589	.601
	3a Max C/B bef.Cleanup	3050	24.9	21.3	16.1	39.7	34.2	27.7	168.	145.	123.	26.0	22.0	17.8	7.03	6.28	5.73	10.5	9.06	7.71	.676	.672	.612
	3b Max C/B bef.Cleanup	915	30.5	26.4	20.6	48.6	42.7	35.9	176.	157.	148.	28.7	25.6	22.7	7.36	6.83	6.68	11.3	10.2	9.44	.773	.804	.775
	4 Min C/B bef.Cleanup	N/A	15.9	15.1	14.6	31.7	30.9	30.6	149.	147.	148.	21.0	20.6	20.8	6.36	6.41	6.60	8.92	8.84	8.99	.598	.578	.635
90	1a Cleanup bef.max C/B	3050	9.51	9.96	10.8	15.0	15.8	16.4	48.6	57.2	64.6	7.08	8.12	9.07	2.59	2.87	3.14	3.22	3.65	4.05	.388	.517	.653
	1b Cleanup bef.max C/B	915	9.51	9.69	10.4	15.0	15.8	15.6	48.6	57.2	56.5	7.08	8.12	8.05	2.59	2.87	2.88	3.22	3.65	3.64	.338	.517	.568
	2 Cleanup bef.min C/B	N/A	9.92	10.2	10.4	15.5	15.9	15.6	53.8	59.0	56.5	7.71	8.32	8.05	2.76	2.92	2.88	3.53	3.73	3.64	.441	.534	.568
	3a Max C/B bef.Cleanup	3050	15.0	11.8	7.40	16.7	13.3	11.6	70.1	40.9	27.3	9.65	6.07	4.39	2.95	2.12	1.80	4.13	2.70	2.07	.618	.439	.279
	3b Max C/B bef.Cleanup	915	15.5	11.5	7.44	16.7	13.3	11.6	70.1	40.9	27.3	9.66	6.07	4.39	2.95	2.12	1.80	4.13	2.70	2.07	.618	.439	.278
	4 Min C/B bef.Cleanup	N/A	10.5	10.2	9.29	14.9	14.8	13.8	50.8	51.0	41.5	7.14	7.27	6.22	2.43	2.56	2.35	3.17	3.26	2.86	.482	.486	.431
95	1a Cleanup bef.max C/B	3050	7.71	7.17	6.18	7.75	6.94	6.22	15.5	11.9	7.39	2.40	1.90	1.22	.994	.801	.538	1.14	.908	.592	.284	.253	.153
	1b Cleanup bef.max C/B	915	7.71	7.17	6.09	7.76	6.94	6.21	15.5	11.9	7.39	2.40	1.90	1.22	.994	.801	.538	1.14	.908	.592	.284	.253	.153
	2 Cleanup bef.min C/B	N/A	7.80	7.17	6.09	7.79	6.94	6.21	15.5	11.9	7.39	2.40	1.90	1.22	.994	.801	.538	1.14	.908	.592	.284	.253	.153
	3a Max C/B bef.Cleanup	3050	9.10	5.64	5.82	6.47	5.18	6.09	15.2	4.22	6.08	2.13	.732	1.02	.724	.340	.473	.506	.363	.506	.262	.103	.125
	3b Max C/B bef.Cleanup	915	8.84	5.64	5.82	6.47	5.18	6.09	15.2	4.22	6.08	2.13	.732	1.02	.724	.340	.473	.506	.363	.506	.262	.103	.125
	4 Min C/B bef.Cleanup	N/A	7.08	6.72	6.00	6.49	6.35	6.20	8.16	8.70	6.08	1.34	1.42	1.02	.535	.603	.473	.623	.679	.506	.168	.182	.125
100	1a Cleanup bef.max C/B	3050	5.37	4.47	4.38	3.65	3.13	3.09	2.83	.970	.970	.459	.177	.177	.225	.092	.092	.234	.092	.092	.114	.044	.044
	1b Cleanup bef.max C/B	915	5.37	4.47	4.38	3.65	3.13	3.09	2.83.	.970	.970	.459	.177	.177	.225	.092	.092	.234	.092	.092	.114	.044	.044
	2 Cleanup bef.min C/B	N/A	5.37	4.47	4.38	3.65	3.13	3.09	2.83	.970	.970	.459	.177	.177	.225	.092	.092	.234	.092	.092	.114	.044	.044
	3a Max C/B bef.Cleanup	3050	5.01	4.02	4.29	3.08	2.96	3.08	1.90	.041	.970	.318	.036	.177	.158	.025	.092	.163	.021	.092	.079	.009	.044
	3b Max C/B bef.Cleanup	915	5.01	4.02	4.29	3.08	2.96	3.08	1.90	.041	.970	.318	.036	.177	.158	.025	.092	.163	.021	.092	.079	.009	.044
	4 Min C/B bef.Cleanup	N/A	4.65	4.47	4.38	3.21	3.13	3.09	.970	.970	.970	.177	.177	.177	.092	.092	.092	.092	.092	.092	.044	.044	.044
105	1a Cleanup bef.max C/B	3050	3.57	3.21	3.21	2.46	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.57	3.21	3.21	2.46	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.57	3.21	3.21	2.46	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.85	3.21	3.21	2.21	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.85	3.21*	3.21	2.21	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.39	3.21	3.21	2.40	2.35	2.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110	1a Cleanup bef.max C/B	3050	2.58	2.58	2.58	1.36	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	2.58	2.58	2.58	1.36	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	2.58	2.58	2.58	1.36	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.59	2.58	2.58	1.35	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.49	2.58	2.58	1.35	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.58	2.58	2.58	1.34	1.36	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	1a Cleanup bef.max C/B	3050	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	2.04	2.04	2.04	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	98.7	98.7	98.7	101.6	99.4	98.8	97.6	96.1	94.5	90.5	91.9	91.9	86.3	85.6	86.5	-	-	-	1.34	1.35	1.45
	1b Cleanup bef.max C/B	915	98.7	98.7	98.7	101.6	99.4	98.8	97.6	96.1	94.5	90.5	91.9	91.4	85.7	86.6	86.5	-	-	-	1.39	1.42	1.38
	2 Cleanup bef.min C/B	N/A	98.7	98.7	98.7	101.6	99.4	98.8	97.6	96.1	94.5	91.4	92.0	91.4	86.5	86.3	86.3	-	-	-	1.42	1.42	1.37
	3a Max C/B bef.Cleanup	3050	98.7	98.7	98.7	100.4	96.4	98.8	97.8	94.2	92.1	94.6	91.8	88.4	91.7	89.3	86.4	-	-	-	1.64	1.22	1.06
	3b Max C/B bef.Cleanup	915	98.7	98.7	98.7	100.5	96.4	98.8	97.8	94.2	92.1	94.6	91.8	88.5	91.7	89.3	87.1	-	-	-	1.73	1.36	1.22
	4 Min C/B bef.Cleanup	N/A	98.7	98.7	98.7	99.9	99.0	98.8	96.1	95.3	94.1	91.8	91.6	90.1	87.3	87.0	86.6	-	-	-	1.29	1.29	1.24

*Recent update of profile data base in Ref. A-2 indicates that the drag ÷ lift for the cleanup condition is too high in these data, making the values in procedures 1, 2 & 4 slightly higher than they should be.

TABLE A-8: DATA SUMMARY FOR DC10-10 AIRCRAFT AT 440,000 LBS.

	QUANTITY		Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
	Initiation Altitude		122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	20.6	19.5	19.1	40.4	41.1	41.9	204	210.	214.	29.8	30.5	31.0	8.40	8.58	8.69	12.3	12.6	12.8	.730	.714	.758
	1b Cleanup bef.max C/B	915	22.3	20.9	20.1	43.8	43.7	44.1	209.	215.	219.	31.4	31.6	32.2	8.66	8.79	8.93	12.8	13.0	13.2	.789	.757	.796
	2 Cleanup bef.min C/B	N/A	19.9	19.9	20.0	42.6	43.7	44.2	216.	218.	220.	31.6	31.8	32.3	8.79	8.85	8.95	13.0	13.1	13.2	.750	.760	.801
	3a Max C/B bef.Cleanup	3050	29.8	26.3	21.5	50.4	44.9	38.7	205.	197.	185.	32.7	30.6	27.5	8.23	8.15	8.39	12.8	12.3	11.3	.670	.808	.790
	3b Max C/B bef.Cleanup	915	32.6	29.0	24.0	58.6	52.8	45.9	210.	205.	199.	34.4	33.0	30.9	8.41	8.49	8.39	13.3	13.0	12.5	.831	.896	.919
	4 Min C/B bef.Cleanup	N/A	20.7	20.8	20.7	43.2	44.0	44.0	207.	212.	216.	30.7	31.5	31.8	8.52	8.70	8.82	12.6	12.9	13.0	.760	.779	.837
90	1a Cleanup bef.max C/B	3050	13.7	13.9	14.4	20.4	21.2	20.5	90.0	98.0	93.9	12.5	13.6	13.1	3.94	4.19	4.07	5.40	5.82	5.62	.560	.765	.793
	1b Cleanup bef.max C/B	915	13.7	13.9	14.5	20.4	21.2	20.5	90.0	98.0	95.2	12.5	13.6	13.3	3.94	4.19	4.11	5.40	5.82	5.70	.560	.765	.809
	2 Cleanup bef.min C/B	N/A	14.4	14.5	14.5	21.7	21.6	20.5	99.1	99.1	95.2	13.8	13.8	13.3	4.23	4.23	4.11	5.90	5.90	5.70	.646	.780	.809
	3a Max C/B bef.Cleanup	3050	17.8	14.8	10.7	21.3	17.9	15.8	97.5	80.1	62.1	13.8	11.0	8.73	3.87	3.42	3.04	5.70	4.73	3.91	.871	.689	.442
	3b Max C/B bef.Cleanup	915	17.8	14.9	10.7	21.3	17.9	15.8	97.5	80.1	62.1	13.8	11.0	8.73	3.87	4.42	3.04	5.70	4.73	3.91	.871	.689	.442
	4 Min C/B bef.Cleanup	N/A	14.1	14.0	13.6	20.7	20.2	19.3	90.9	92.8	86.1	12.6	12.9	11.9	3.85	4.03	3.81	5.38	5.55	5.17	.632	.742	.699
95	1a Cleanup bef.max C/B	3050	11.0	9.87	8.25	10.5	9.19	8.26	39.6	29.5	22.5	5.69	4.26	3.43	1.96	1.54	1.31	2.53	1.93	1.58	.349	.496	.402
	1b Cleanup bef.max C/B	915	11.0	9.87	8.25	10.5	9.19	8.26	39.6	29.5	22.5	5.69	4.26	3.43	1.96	1.54	1.31	2.53	1.93	1.58	.349	.496	.402
	2 Cleanup bef.min C/B	N/A	11.1	9.87	8.25	10.6	9.19	8.26	41.0	29.5	22.5	5.90	4.26	3.43	2.01	1.54	1.31	2.61	1.93	1.58	.640	.596	.402
	3a Max C/B bef.Cleanup	3050	10.9	8.16	7.98	8.33	7.22	8.13	21.8	17.3	22.5	3.01	2.62	3.43	.981	1.05	1.31	.874	1.23	1.58	.281	.316	.402
	3b Max C/B bef.Cleanup	915	10.9	8.12	7.98	8.33	7.22	8.13	21.8	17.3	22.5	3.01	2.62	3.43	.981	1.05	1.31	.874	1.23	1.58	.281	.316	.402
	4 Min C/B bef.Cleanup	N/A	10.1	9.06	8.25	9.40	8.65	8.26	33.8	26.1	22.5	4.87	3.86	3.43	1.72	1.43	1.31	2.19	1.76	1.58	.554	.437	.402
100	1a Cleanup bef.max C/B	3050	7.40	6.09	5.82	4.96	4.19	4.12	9.86	5.45	4.14	1.48	.864	.661	.544	.355	.290	.672	.408	.321	.273	.164	.117
	1b Cleanup bef.max C/B	915	7.44	6.09	5.82	4.96	4.19	4.12	9.86	5.45	4.14	1.48	.864	.661	.544	.355	.290	.672	.408	.321	.273	.164	.117
	2 Cleanup bef.min C/B	N/A	7.44	6.09	5.82	4.96	4.19	4.12	9.86	5.45	4.14	1.48	.864	.661	.544	.355	.290	.672	.408	.321	.273	.164	.117
	3a Max C/B bef.Cleanup	3050	6.54	5.46	5.82	4.17	3.97	4.12	6.76	2.83	4.14	1.07	.459	.661	.420	.225	.290	.496	.235	.321	.100	.070	.117
	3b Max C/B bef.Cleanup	915	6.54	5.46	5.82	4.17	3.97	4.12	6.76	2.83	4.14	1.07	.459	.661	.420	.225	.290	.496	.235	.321	.100	.070	.117
	4 Min C/B bef.Cleanup	N/A	7.26	6.09	5.82	4.60	4.19	4.12	6.76	5.45	4.14	1.07	.864	.661	.420	.355	.290	.492	.408	.321	.137	.164	.117
105	1a Cleanup bef.max C/B	3050	4.83	4.38	4.38	3.27	3.15	3.15	1.90	.970	.970	.318	.177	.177	.158	.092	.092	.163	.092	.092	.122	.068	.068
	1b Cleanup bef.max C/B	915	4.83	4.38	4.38	3.27	3.15	3.15	1.90	.970	.970	.318	.177	.177	.158	.092	.092	.163	.092	.092	.122	.068	.068
	2 Cleanup bef.min C/B	N/A	4.83	4.38	4.38	3.27	3.15	3.15	1.90	.970	.970	.318	.177	.177	.158	.092	.092	.163	.092	.092	.122	.068	.068
	3a Max C/B bef.Cleanup	3050	4.11	4.38	4.38	2.97	3.15	3.15	.041	.970	.970	.036	.177	.177	.025	.092	.092	.021	.092	.092	.014	.068	.068
	3b Max C/B bef.Cleanup	915	4.11	4.38	4.38	2.97	3.15	3.15	.041.	.970	.970	.036	.177	.177	.025	.092	.092	.021	.092	.092	.014	.068	.068
	4 Min C/B bef.Cleanup	N/A	4.74	4.38	4.38	3.25	3.15	3.15	1.90	.970	.970	.318	.177	.177	.158	.092	.092	.163	.092	.092	.122	.068	.068
110	1a Cleanup bef.max C/B	3050	3.57	3.48	3.48	1.81	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.57	3.48	3.48	1.81	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.57	3.48	3.48	1.81	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	3.48	3.48	3.48	1.80	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	3.48	3.48	3.48	1.80	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.57	3.48	3.48	1.81	1.80	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	1a Cleanup bef.max C/B	3050	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	0.51	0.51	0.51	0.19	0.19	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	0.51	0.51	0.51	0.19	0.19	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	.513	.513	.513	.189	.189	.189	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
[illegible]	1a Cleanup bef.max C/B	3050	97.6	97.6	97.6	105.2	103.6	103.6	101.5	99.1	98.4	97.4	95.7	94.0	90.9	92.1	91.1				2.03	2.21	2.14
	1b Cleanup bef.max C/B	915	97.6	97.6	97.6	105.2	103.6	103.6	101.5	99.1	98.4	97.4	95.7	94.0	90.9	92.1	91.1				2.09	2.25	2.19
	2 Cleanup bef.min C/B	N/A	97.6	97.6	97.6	105.2	103.6	103.6	101.6	99.1	98.4	97.4	95.7	94.0	92.1	92.2	91.1				2.43	2.37	2.20
	3a Max C/B bef.Cleanup	3050	97.3	97.6	97.6	103.3	103.5	103.6	100.1	96.8	98.4	96.8	94.0	91.5	93.4	91.2	88.7				1.94	1.95	1.82
	3b Max C/B bef.Cleanup	915	97.3	97.6	97.6	103.3	103.5	103.6	100.1	96.8	98.4	96.8	94.0	91.5	93.4	91.2	88.7				2.10	2.04	1.95
	4 Min C/B bef.Cleanup	N/A	97.6	97.6	97.6	105.1	103.6	103.6	100.5	99.0	98.4	96.2	94.9	93.8	91.6	89.6	90.5				2.21	2.19	2.12

*Recent update of profile data base in Ref. A-2 indicates that the drag ÷ lift for the cleanup condition is too high in these data, making the values in procedures 1, 2 & 4 slightly higher than they should be.

TABLE A-9: DATA SUMMARY FOR B707-320B AIRCRAFT AT 260,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	34.6	29.3	24.8	86.4	74.5	77.1	315.	320.	377.	52.0	47.0	56.3	14.1	14.0	16.3	11.2	10.2	12.2	.598	.591	.754
	1b Cleanup bef.max C/B	915	30.8	26.6	22.1	94.9	90.0	84.1	328.	371.	421.	55.2	59.6	63.0	14.6	16.3	17.7	11.9	12.9	13.6	.573	.699	.779
	2 Cleanup bef.min C/B	N/A	22.0	22.0	22.1	76.2	79.8	84.1	360.	387.	421.	54.7	58.5	63.0	15.4	16.6	17.7	11.8	12.6	13.6	.647	.718	.779
	3a Max C/B bef.Cleanup	3050	--	--	38.5	125.	120.	103.	366.	370.	363.	67.8	66.8	61.2	15.6	16.1	15.9	14.6	14.4	13.2	.831	.874	.770
	3b Max C/B bef.Cleanup	915	40.1	35.4	29.0	126.	114.	97.2	349.	345.	370.	63.9	60.8	62.0	14.8	15.0	16.3	13.8	13.1	13.4	.708	.638	.712
	4 Min C/B bef.Cleanup	N/A	22.5	22.7	22.7	75.5	78.6	81.9	346.	362.	391.	53.2	55.7	59.6	14.7	15.6	16.8	11.5	12.0	12.9	.650	.672	.733
90	1a Cleanup bef.max C/B	3050	24.6	20.6	16.3	49.6	42.6	43.9	209.	200.	225.	32.5	27.7	31.7	9.47	8.80	9.95	7.02	5.98	6.85	.847	.773	.813
	1b Cleanup bef.max C/B	915	26.3	22.2	17.6	59.5	55.0	51.5	222.	235.	263.	36.5	36.8	37.6	10.1	10.6	11.2	7.88	7.95	8.12	.910	.973	.950
	2 Cleanup bef.min C/B	N/A	17.5	17.5	17.6	47.7	49.3	51.5	231.	243.	262.	33.6	35.1	37.6	10.1	10.6	11.2	7.26	7.58	8.12	.830	.887	.950
	3a Max C/B bef.Cleanup	3050	38.6	33.5	26.2	78.1	68.3	54.9	233.	229.	230.	40.7	38.3	36.1	9.85	9.86	10.3	8.79	8.27	7.80	.812	.933	1.04
	3b Max C/B bef.Cleanup	915	35.3	30.7	24.0	81.5	72.4	59.4	232.	235.	243.	40.8	40.0	38.8	9.79	10.1	10.8	8.81	8.64	8.38	.733	.904	1.01
	4 Min C/B bef.Cleanup	N/A	18.2	18.3	18.4	47.0	48.6	50.4	220.	232.	245.	32.0	33.8	35.7	9.38	10.1	10.7	6.91	7.30	7.71	.859	.893	.933
95	1a Cleanup bef.max C/B	3050	16.6	13.0	11.4	27.8	26.1	27.7	121.	100.	123.	17.7	14.2	17.5	5.79	5.10	6.01	3.82	3.07	3.78	1.09	.640	.822
	1b Cleanup bef.max C/B	915	22.8	18.7	14.2	31.9	29.8	31.2	132.	130.	147.	20.6	19.8	21.0	6.29	6.33	6.79	4.45	4.28	4.54	1.38	1.19	1.17
	2 Cleanup bef.min C/B	N/A	14.1	14.1	14.2	28.8	29.8	31.2	134.	137.	147.	19.1	19.6	21.0	6.27	6.44	6.79	4.13	4.23	4.54	1.06	1.03	1.17
	3a Max C/B bef.Cleanup	3050	27.2	22.8	16.5	43.4	36.6	28.6	165.	139.	122.	26.5	22.0	18.0	7.14	6.23	5.88	5.72	4.75	3.89	1.06	1.00	1.14
	3b Max C/B bef.Cleanup	915	29.8	25.2	18.5	48.4	41.3	33.1	169.	147	139.	28.0	24.2	21.1	7.32	6.57	6.50	6.05	5.23	4.56	1.21	1.22	1.45
	4 Min C/B bef.Cleanup	N/A	13.8	13.9	14.0	27.6	28.4	29.5	120.	127.	435.	17.0	18.2	19.4	5.47	5.98	6.38	3.67	3.93	4.19	.930	1.02	1.07
100	1a Cleanup bef.max C/B	3050	10.5	8.97	10.1	14.9	15.5	16.9	44.1	52.3	64.3	6.62	7.70	9.15	2.53	2.87	3.25	1.43	1.66	1.98	.567	.703	.993
	1b Cleanup bef.max C/B	915	10.5	8.97	10.5	14.9	15.5	17.2	44.1	52.3	64.3	6.62	7.70	9.15	2.53	2.87	3.25	1.43	1.66	1.98	.567	.703	.993
	2 Cleanup bef.min C/B	N/A	10.1	10.1	10.5	16.7	16.9	17.2	58.3	64.3	64.3	8.34	9.15	9.15	3.01	3.25	3.25	1.80	1.98	1.98	.706	.864	.993
	3a Max C/B bef.Cleanup	3050	20.0	15.8	9.69	25.4	19.6	14.3	109.	84.0	42.4	15.7	11.8	6.41	4.26	3.54	2.48	3.39	2.55	1.38	1.61	1.40	.661
	3b Max C/B bef.Cleanup	915	20.0	15.8	9.78	25.5	19.7	14.3	109.	84.0	42.4	15.7	11.8	6.41	4.26	3.54	2.48	3.39	2.55	1.38	1.61	1.40	.661
	4 Min C/B bef.Cleanup	N/A	9.96	10.0	10.1	15.7	16.2	16.3	53.0	54.8	59.2	7.57	7.85	8.54	2.70	2.83	3.09	1.64	1.70	1.84	.586	.692	.932
105	1a Cleanup bef.max C/B	3050	6.99	7.80	7.44	9.40	9.80	9.21	19.0	20.8	18.1	3.00	3.21	2.81	1.19	1.25	1.12	.648	.693	.607	.497	.593	.547
	1b Cleanup bef.max C/B	915	6.99	7.80	7.44	9.40	9.80	9.21	19.0	20.8	18.1	3.00	3.21	2.81	1.19	1.25	1.12	.648	.693	.607	.497	.593	.547
	2 Cleanup bef.min C/B	N/A	8.07	8.07	7.44	10.3	9.98	9.21	25.2	23.9	18.1	3.83	3.63	2.81	1.44	1.38	1.12	.827	.784	.607	.690	.691	.547
	3a Max C/B bef.Cleanup	3050	13.7	9.78	6.41	11.9	9.25	8.56	38.1	20.5	13.7	5.43	2.89	2.19	1.77	1.01	0.934	1.17	.624	.473	.768	.566	.403
	3b Max C/B bef.Cleanup	915	13.7	9.78	6.45	11.9	9.25	8.56	38.1	20.5	13.7	5.43	2.89	2.19	1.77	1.01	0.934	1.17	.624	.473	.768	.566	.403
	4 Min C/B bef.Cleanup	N/A	7.89	7.89	7.26	9.95	9.60	9.11	25.2	22.5	16.4	3.83	3.43	2.59	1.44	1.31	1.06	.827	.741	.559	.691	.645	.496
110	1a Cleanup bef.max C/B	3050	6.18	5.73	5.28	4.70	4.27	4.08	5.45	4.14	2.83	.864	.661	.459	.355	.290	.225	.186	.143	.099	.226	.206	.139
	1b Cleanup bef.max C/B	915	6.18	5.73	5.28	4.70	4.27	4.08	5.45	4.14	2.83	.864	.661	.459	.355	.290	.225	.186	.143	.099	.226	.206	.139
	2 Cleanup bef.min C/B	N/A	6.36	5.73	5.28	4.75	4.27	4.08	5.45	4.14	2.83	.864	.661	.459	.355	.290	.225	.186	.143	.099	.226	.206	.139
	3a Max C/B bef.Cleanup	3050	8.97	5.19	5.24	5.81	3.73	4.06	15.2	2.83	2.83	2.13	.459	.459	.724	.225	.225	.460	.099	.099	.551	.139	.139
	3b Max C/B bef.Cleanup	915	8.97	5.19	5.28	5.79	3.73	4.06	15.2	2.83	2.83	2.13	.459	.459	.724	.225	.225	.460	.099	.099	.551	.139	.139
	4 Min C/B bef.Cleanup	N/A	6.27	5.64	5.28	4.69	4.20	4.08	5.45	4.14	2.83	.864	.661	.459	.355	.290	.225	.186	.143	.099	.226	.139	.139
115	1a Cleanup bef.max C/B	3050	4.56	4.02	4.02	3.17	2.88	2.88	.970	.041	.041	.177	.036	.036	.092	.025	.225	.038	.008	.008	.080	.016	.016
	1b Cleanup bef.max C/B	915	4.56	4.02	4.02	3.17	2.88	2.88	.970	.041	.041	.177	.036	.036	.092	.025	.025	.038	.008	.008	.080	.016	.016
	2 Cleanup bef.min C/B	N/A	4.56	4.02	4.02	3.17	2.88	2.88	.970	.041	.041	.177	.036	.036	.092	.025	.025	.038	.008	.008	.080	.016	.016
	3a Max C/B bef.Cleanup	3050	5.55	3.84	4.02	3.40	2.82	2.88	2.83	.041	.041	.459	.036	.036	.225	.025	.025	.099	.008	.008	.207	.016	.016
	3b Max C/B bef.Cleanup	915	5.55	3.84	4.02	3.40	2.82	2.88	2.83	.041	.041	.459	.036	.036	.225	.025	.025	.099	.008	.008	.207	.016	.016
	4 Min C/B bef.Cleanup	N/A	4.56	4.02	4.02	3.15	2.88	2.88	.970	.041	.041	.177	.036	.036	.092	.025	.025	.038	.008	.008	.080	.016	.016
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	110.3	110.4	110.4	114.4	112.5	112.0	108.2	108.3	106.7	101.3	99.2	102.0	98.1	95.5	92.6				3.91	3.52	4.08
	1b Cleanup bef.max C/B	915	110.3	110.4	110.4	114.4	112.7	112.0	108.2	108.3	106.7	101.3	99.2	102.2	98.1	95.5	96.6				4.23	4.38	4.59
	2 Cleanup bef.min C/B	N/A	110.3	110.4	110.4	114.4	112.7	112.0	109.7	108.3	106.7	101.9	102.0	102.2	96.5	96.5	96.6				4.24	4.41	4.59
	3a Max C/B bef.Cleanup	3050	109.3	109.9	110.4	116.5	110.7	112.0	113.4	108.5	104.6	109.8	105.4	100.5	105.8	102.2	95.3				5.84	5.15	4.17
	3b Max C/B bef.Cleanup	915	109.3	110.3	110.4	116.5	110.7	112.0	113.4	108.5	104.6	109.8	105.4	100.6	105.8	102.2	98.1				5.79	4.88	4.42
	4 Min C/B bef.Cleanup	N/A	110.3	110.4	110.4	114.5	112.6	112.0	109.1	108.1	106.6	101.7	101.8	101.4	96.3	96.4	96.6				4.02	4.08	4.32

TABLE A-10: DATA SUMMARY FOR B707-320B AIRCRAFT AT 333,6,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot.Pop.(mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	41.9	37.9	36.3	117.	115.	120.	418.	463.	493.	69.3	73.4	78.4	17.1	18.5	19.5	15.0	15.9	16.9	.705	.788	.853
	1b Cleanup bef.max C/B	915	38.4	35.3	33.2	124.	123.	123.	423.	471.	498.	71.3	75.7	80.0	17.3	18.8	19.8	15.4	16.4	17.3	.699	.742	.828
	2 Cleanup bef.min C/B	N/A	31.7	31.9	32.4	109.	115.	121.	426.	475.	501.	69.0	75.7	80.3	17.3	18.9	19.9	14.9	16.4	17.3	.656	.776	.837
	3a Max C/B bef.Cleanup	3050	-	-	-	144.	143.	154.	441.	439.	506.	80.3	79.1	88.9	18.3	18.3	20.6	17.3	17.1	17.6	.708	.800	1.07
	3b Max C/B bef.Cleanup	915	-	-	39.7	142.	145.	137.	428.	440.	477.	77.1	79.4	81.4	17.8	18.3	19.4	16.7	17.2	17.6	.761	.880	.908
	4 Min C/B bef.Cleanup	N/A	33.0	33.6	34.8	109.	114.	120.	398.	425.	475.	66.1	70.0	76.6	16.3	17.4	19.0	14.3	15.1	16.5	.656	.675	.791
90	1a Cleanup bef.max C/B	3050	31.4	28.1	26.3	71.3	68.8	70.8	295.	314.	332.	46.3	47.7	50.6	12.1	12.7	13.3	10.0	10.3	10.9	.939	.990	1.10
	1b Cleanup bef.max C/B	915	31.7	28.5	26.4	77.9	75.7	76.1	302.	327.	340.	48.5	51.5	53.0	12.4	13.3	13.7	10.5	11.1	11.4	.979	1.09	1.09
	2 Cleanup bef.min C/B	N/A	25.0	25.2	25.6	68.4	71.4	74.7	309.	328.	340.	47.6	50.4	53.0	12.5	13.2	13.7	10.3	10.9	11.4	.944	1.04	1.13
	3a Max C/B bef.Cleanup	3050	-	42.3	37.6	102.	94.4	91.7	325.	307.	328.	57.2	53.0	53.9	13.4	12.7	13.4	12.4	11.4	11.6	1.23	1.10	1.17
	3b Max C/B bef.Cleanup	915	37.4	30.1	32.8	96.2	93.2	84.2	306.	298.	321.	52.3	50.7	51.8	12.5	12.3	13.1	11.3	11.0	11.2	.933	.944	1.08
	4 Min C/B bef.Cleanup	N/A	26.5	26.9	20.1	68.4	71.2	74.3	281.	304.	326.	44.7	48.0	50.8	11.6	12.5	13.2	9.66	10.4	11.0	.962	1.00	1.09
95	1a Cleanup bef.max C/B	3050	23.0	20.1	18.9	42.2	40.8	42.4	198.	208.	217.	29.9	30.4	31.4	8.43	8.72	8.90	6.46	6.57	6.78	1.36	1.33	1.32
	1b Cleanup bef.max C/B	915	26.8	23.6	21.5	46.2	44.7	46.0	203.	216.	226.	31.4	32.4	33.9	8.63	9.06	9.32	6.78	7.00	7.32	1.49	1.53	1.55
	2 Cleanup bef.min C/B	N/A	20.1	20.3	20.8	42.2	43.7	45.6	211.	218.	224.	31.1	32.2	33.3	8.77	9.09	9.23	6.72	7.00	7.19	1.36	1.44	1.46
	3a Max C/B bef.Cleanup	3050	34.3	30.2	29.9	59.7	52.7	47.9	216.	211.	217.	35.7	33.8	33.4	8.83	8.81	9.06	7.71	7.30	7.21	1.57	1.46	1.64
	3b Max C/B bef.Cleanup	915	33.6	29.9	24.5	61.7	54.7	47.5	216.	212.	215.	36.0	34.2	33.0	8.85	8.87	9.01	7.78	7.39	7.13	1.60	1.49	1.60
	4 Min C/B bef.Cleanup	N/A	20.7	20.9	21.2	40.9	42.5	43.5	187.	203.	214.	27.9	30.5	31.7	7.78	8.62	8.87	6.03	6.59	6.85	1.28	1.38	1.46
100	1a Cleanup bef.max C/B	3050	16.5	14.6	16.2	24.0	24.7	26.3	114.	122.	128.	16.1	16.9	18.0	4.85	5.07	5.31	3.48	3.65	3.89	1.16	1.27	1.63
	1b Cleanup bef.max C/B	915	16.6	14.6	16.2	24.0	24.7	26.4	116.	122.	129.	16.3	16.9	18.2	4.91	5.07	5.34	3.52	3.65	3.93	1.17	1.27	1.66
	2 Cleanup bef.min C/B	N/A	15.7	15.9	16.9	25.3	26.0	26.8	124.	125.	131.	17.3	17.6	18.5	5.15	5.21	5.40	3.74	3.80	3.99	1.23	1.35	1.71
	3a Max C/B bef.Cleanup	3050	24.5	21.0	16.6	33.9	29.3	24.3	125.	126.	119.	19.8	19.0	16.8	5.04	5.26	5.00	4.28	4.10	3.63	1.16	1.62	1.54
	3b Max C/B bef.Cleanup	915	24.5	21.0	16.7	33.9	29.3	24.3	125.	126.	119.	19.8	19.1	16.8	5.04	5.26	5.00	4.28	4.13	3.63	1.16	1.63	1.54
	4 Min C/B bef.Cleanup	N/A	15.3	15.6	15.7	23.8	24.8	24.5	107.	117.	121.	14.9	16.5	16.9	4.50	4.93	5.07	3.22	3.56	3.65	.982	1.33	1.49
105	1a Cleanup bef.max C/B	3050	11.6	12.7	11.6	14.9	14.9	13.6	65.1	64.4	55.0	8.83	8.81	7.61	2.79	2.77	2.47	1.91	1.90	1.64	1.45	1.54	1.36
	1b Cleanup bef.max C/B	915	11.6	12.7	11.7	14.9	14.9	13.6	65.1	64.4	54.9	8.83	8.81	7.61	2.79	2.77	2.47	1.91	1.90	1.64	1.45	1.54	1.36
	2 Cleanup bef.min C/B	N/A	12.7	12.8	11.8	15.7	14.9	13.6	69.2	65.7	54.9	9.42	8.99	7.61	2.93	2.81	2.47	2.03	1.94	1.64	1.54	1.58	1.36
	3a Max C/B bef.Cleanup	3050	17.7	14.5	10.5	18.4	14.9	13.0	87.8	62.3	50.6	12.4	8.68	6.99	3.56	2.71	2.33	2.68	1.87	1.51	2.06	1.51	1.22
	3b Max C/B bef.Cleanup	915	17.7	14.5	10.5	18.4	14.9	13.0	87.8	62.3	50.6	12.4	8.68	6.99	3.56	2.71	2.33	2.68	1.87	1.51	2.06	1.51	1.22
	4 Min C/B bef.Cleanup	N/A	12.3	12.1	11.3	14.8	14.1	13.5	63.1	58.0	53.5	8.63	8.02	7.40	2.73	2.57	2.43	1.86	1.73	1.60	1.41	1.41	1.31
110	1a Cleanup bef.max C/B	3050	10.1	8.79	8.16	7.11	6.29	6.01	18.7	15.3	11.7	2.61	2.20	1.77	.880	.775	.655	.564	.475	.382	.442	.440	.299
	1b Cleanup bef.max C/B	915	10.1	8.88	8.16	7.13	6.30	6.01	18.7	15.3	11.7	2.61	2.20	1.77	.880	.775	.655	.564	.475	.382	.442	.440	.299
	2 Cleanup bef.min C/B	N/A	10.1	8.79	8.16	7.14	6.29	6.01	20.3	15.3	11.7	2.81	2.20	1.77	.933	.775	.655	.607	.475	.382	.508	.440	.299
	3a Max C/B bef.Cleanup	3050	12.0	8.97	8.16	8.18	6.05	6.01	25.9	15.3	11.7	3.56	2.20	1.77	1.07	0.77	0.65	.769	.475	.382	.613	.440	.298
	3b Max C/B bef.Cleanup	915	12.0	8.97	8.16	8.18	6.05	6.01	25.9	15.3	11.7	3.56	2.20	1.77	1.07	.775	0.65	.769	.475	.382	.613	.440	.299
	4 Min C/B bef.Cleanup	N/A	9.69	8.61	8.16	6.87	6.22	6.01	18.6	13.5	11.7	2.57	1.98	1.77	.855	.715	.655	.555	.428	.382	.429	.368	.299
115	1a Cleanup bef.max C/B	3050	7.08	6.18	6.18	4.77	4.33	4.33	8.08	5.45	5.45	1.27	.864	.864	.485	.355	.355	.274	.187	.187	.573	.390	.390
	1b Cleanup bef.max C/B	915	7.08	6.18	6.18	4.77	4.33	4.33	8.08	5.45	5.45	1.27	.864	.864	.485	.355	.355	.274	.187	.187	.573	.390	.390
	2 Cleanup bef.min C/B	N/A	7.08	6.18	6.18	4.77	4.33	4.33	8.08	5.45	5.45	1.27	.864	.864	.485	.355	.355	.274	.187	.187	.573	.390	.390
	3a Max C/B bef.Cleanup	3050	7.98	6.09	6.18	5.17	4.32	4.33	11.6	5.45	5.45	1.70	.864	.864	.604	.355	.355	.367	.187	.187	.767	.390	.390
	3b Max C/B bef.Cle	915	7.98	6.09	6.18	5.17	4.32	4.33	11.6	5.45	5.45	1.70	.864	.864	.604	.355	.355	.367	.187	.187	.767	.390	.390
	4 Min C/B bef.Cl	N/A	6.54	5.73	6.18	4.75	4.33	4.33	8.08	5.45	5.45	1.27	.864	.864	.485	.355	.355	.274	.187	.187	.573	.390	.390
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	110.1	110.1	110.1	121.4	120.8	120.8	116.2	114.1	114.0	111.3	109.4	108.1	103.5	104.8	103.9				6.61	6.75	6.95
	1b Cleanup bef.max C/B	915	110.1	110.1	110.1	121.4	120.8	120.8	116.2	114.1	114.0	111.3	109.4	108.1	103.5	104.8	103.9				6.80	7.00	7.18
	2 Cleanup bef.min C/B	N/A	110.1	110.1	110.1	121.4	120.8	120.8	116.2	114.1	114.0	111.3	109.4	108.1	104.8	105.0	104.1				6.81	7.02	7.19
	3a Max C/B bef.Cleanup	3050	109.8	110.1	110.1	121.3	120.8	120.8	117.6	113.1	114.0	113.3	109.8	108.0	109.3	106.5	102.8				8.11	7.32	7.33
	3b Max C/B bef.Cleanup	915	109.8	110.1	110.1	121.3	120.8	120.8	117.6	113.1	114.0	113.3	109.8	108.0	109.3	106.5	102.8				7.89	7.28	7.04
	4 Min C/B bef.Cleanup	N/A	110.1	110.1	110.1	121.4	120.8	120.8	116.0	114.1	114.0	110.7	109.0	108.1	104.1	101.5	100.7				6.29	6.55	6.83

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TABLE A-11: DATA SUMMARY FOR B747-200 AIRCRAFT AT 625,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot. Pop. (mil.)			Airport/Runway Level Weighted Pop. (mil.)		
Initiation Altitude			122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	26.1	22.5	21.3	63.7	63.1	64.1	303.	321.	336.	45.6	47.0	48.5	12.8	13.5	13.8	9.85	10.2	10.5	.751	.718	.699
	1b Cleanup bef.max C/B	915	27.7	24.0	22.9	71.5	70.2	70.5	317.	343.	353.	49.6	51.7	52.4	13.4	14.4	14.5	10.7	11.2	11.3	.868	.856	.807
	2 Cleanup bef.min C/B	N/A	23.8	23.3	22.5	66.9	68.8	69.5	318.	346.	352.	48.3	51.5	52.2	13.4	14.4	14.5	10.4	11.1	11.3	.767	.807	.807
	*3a Max C/B bef.Cleanup	3050	-	42.5	34.4	107.	99.1	84.1	338.	328.	318.	60.0	56.5	51.6	14.0	13.8	13.5	13.0	12.2	11.1	1.04	1.01	.926
	3b Max C/B bef.Cleanup	915	42.9	38.8	32.6	108.	98.0	85.6	338.	321.	326.	60.1	54.6	53.0	14.0	13.4	13.8	13.0	11.8	11.4	1.02	.911	.886
	4 Min C/B bef.Cleanup	N/A	28.3	27.2	27.0	74.3	73.4	74.5	302.	310.	337.	48.5	49.0	52.1	12.6	13.1	14.1	10.5	10.6	11.3	.733	.764	.868
90	1a Cleanup bef.max C/B	3050	14.4	13.2	13.7	30.4	33.3	35.2	152.	169.	185.	21.1	23.6	25.7	6.78	7.42	7.89	4.56	5.10	5.55	.601	.635	.744
	1b Cleanup bef.max C/B	915	14.4	13.2	14.6	30.4	33.4	36.0	153.	171.	188.	21.3	23.8	26.1	6.83	7.46	8.00	4.60	5.14	5.64	.612	.647	.767
	2 Cleanup bef.min C/B	N/A	15.2	14.5	14.6	32.8	34.7	35.8	168.	181.	186.	23.1	25.2	25.9	7.25	7.78	7.93	5.03	5.44	5.59	.716	.727	.767
	3a Max C/B bef.Cleanup	3050	27.1	23.0	17.3	42.2	37.1	31.4	163.	152.	148.	26.0	23.6	21.4	6.90	6.74	6.72	5.62	5.10	4.62	.864	.943	.831
	3b Max C/B bef.Cleanup	915	30.8	26.3	19.8	45.8	40.4	34.3	165.	156.	161.	26.7	24.9	24.1	6.98	6.92	7.24	5.77	5.38	5.21	.904	1.02	.985
	4 Min C/B bef.Cleanup	N/A	19.8	18.6	16.0	35.9	35.5	33.4	166.	164.	169.	24.6	24.1	23.8	7.13	7.23	7.42	5.31	5.21	5.14	.830	.864	.801
95	1a Cleanup bef max C/B	3050	10.2	11.1	12.2	18.1	19.9	20.2	75.4	88.7	90.2	10.6	12.5	12.7	3.64	4.08	4.13	2.29	2.70	2.74	.564	.812	.913
	1b Cleanup bef.max C/B	915	10.2	11.6	12.2	18.1	19.9	20.2	75.4	88.7	90.1	10.6	12.5	12.7	3.64	4.08	4.13	2.29	2.70	2.74	.564	.812	.913
	2 Cleanup bef.min C/B	N/A	10.5	11.7	12.2	18.4	20.0	19.9	76.8	88.7	88.8	10.8	12.5	12.5	3.69	4.08	4.07	2.33	2.70	2.70	.584	.812	.915
	3a Max C/B bef.Cleanup	3050	16.8	12.8	8.52	17.9	14.7	14.5	78.1	49.0	45.9	10.9	7.13	6.89	3.23	2.46	2.60	2.35	1.54	1.49	.824	.555	.383
	3b Max C/B bef.Cleanup	915	16.5	12.8	8.52	17.9	14.7	14.5	78.1	49.0	45.9	10.9	7.13	6.89	3.23	2.46	2.60	2.35	1.54	1.49	.824	.555	.383
	4 Min C/B bef.Cleanup	N/A	13.5	11.9	9.78	17.4	16.3	17.0	72.6	62.9	69.0	10.1	8.99	9.81	3.30	3.11	3.42	2.18	1.94	2.12	.744	.590	.628
100	1a Cleanup bef.max C/B	3050	9.20	8.79	8.21	10.0	9.23	8.40	33.0	28.7	22.5	4.87	4.26	3.43	1.75	1.56	1.31	1.05	.920	.740	.595	.563	.465
	1b Cleanup bef.max C/B	915	9.20	8.75	7.98	10.0	9.23	8.40	33.0	28.7	22.5	4.87	4.26	3.43	1.75	1.56	1.31	1.05	.920	.740	.595	.563	.465
	2 Cleanup bef.min C/B	N/A	9.24	8.79	7.71	10.1	9.23	8.32	33.0	28.7	20.8	4.87	4.26	3.21	1.75	1.56	1.25	1.05	.920	.693	.595	.563	.431
	3a Max C/B bef.Cleanup	3050	9.87	6.36	7.04	7.38	6.29	7.99	18.6	9.25	19.0	2.53	1.50	3.00	.830	.671	1.19	.546	.324	.648	.293	.185	.398
	3b Max C/B bef.Cleanup	915	9.87	6.36	7.08	7.38	6.29	7.99	18.6	9.25	19.0	2.53	1.50	3.00	.830	.671	1.19	.546	.324	.648	.293	.185	.398
	4 Min C/B bef.Cleanup	N/A	8.52	7.08	7.89	7.92	7.95	8.37	17.2	19.0	22.5	2.55	3.00	3.43	.981	1.19	1.31	.551	.648	.741	.327	.366	.465
105	1a Cleanup bef.max C/B	3050	6.63	5.82	5.46	4.59	4.06	3.93	6.76	4.14	2.83	1.07	.661	.459	.420	.290	.225	.231	.143	.099	.208	.146	.098
	1b Cleanup bef.max C/B	915	6.63	5.82	5.46	4.59	4.06	3.93	6.76	4.14	2.83	1.07	.661	.459	.420	.290	.225	.231	.143	.099	.208	.146	.098
	2 Cleanup bef.min C/B	N/A	6.63	5.91	5.46	4.59	4.06	3.93	6.76	4.14	2.83	1.07	.661	.459	.420	.290	.225	.231	.143	.099	.208	.146	.098
	3a Max C/B bef.Cleanup	3050	5.64	4.83	5.46	3.58	3.62	3.93	4.14	1.90	2.83	.661	.318	.459	.290	.158	.225	.143	.069	.099	.155	.066	.098
	3b Max C/B bef.Cleanup	915	5.64	4.83	5.46	3.58	3.62	3.93	4.14	1.90	2.83	.661	.318	.459	.290	.158	.225	.143	.069	.099	.155	.066	.098
	4 Min C/B bef.Cleanup	N/A	5.55	5.91	5.46	4.06	4.13	3.93	2.83	4.14	2.83	.459	.661	.459	.225	.290	.225	.099	.143	.099	.033	.165	.098
110	1a Cleanup bef.max C/B	3050	4.56	4.11	4.11	3.17	2.94	2.94	.970	.041	.04	.177	.036	.036	.092	.025	.025	.038	.008	.008	.058	.012	.012
	1b Cleanup bef.max C/B	915	4.56	4.11	4.11	3.17	2.94	2.94	.970	.041	.04	.177	.036	.036	.092	.025	.025	.038	.008	.008	.058	.012	.012
	2 Cleanup bef.min C/B	N/A	4.56	4.11	4.11	3.17	2.94	2.94	.970	.041	.04	.177	.036	.036	.092	.025	.025	.038	.008	.008	.058	.012	.012
	3a Max C/B bef.Cleanup	3050	3.66	4.11	4.11	2.71	2.94	2.94	-	.041	.04	-	.036	.036	-	.025	.025	-	.008	.008	-	.012	.012
	3b Max C/B bef.Cleanup	915	3.66	4.11	4.11	2.71	2.94	2.94	-	.041	.04	-	.036	.036	-	.025	.025	-	.008	.008	-	.012	.012
	4 Min C/B bef.Cleanup	N/A	4.74	4.11	4.11	3.28	2.94	2.94	1.90	.041	.04	.318	.036	.036	.158	.025	.025	.069	.008	.008	.105	.012	.012
115	1a Cleanup bef.max C/B	3050	3.30	3.30	3.30	1.85	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1b Cleanup bef.max C/B	915	3.30	3.30	3.30	1.85	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2 Cleanup bef.min C/B	N/A	3.30	3.30	3.30	1.85	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3a Max C/B bef.Cleanup	3050	3.21	3.30	3.30	1.81	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3b Max C/B bef.Cleanup	915	3.21	3.30	3.30	1.81	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4 Min C/B bef.Cleanup	N/A	3.39	3.30	3.30	1.86	1.85	1.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,800 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	105.1	105.1	105.1	109.5	107.6	107.5	105.2	103.7	102.4	100.2	99.5	98.6	91.1	90.7	93.0				2.78	2.89	2.93
	1b Cleanup bef.max C/B	915	105.1	105.1	105.1	109.5	107.6	107.5	105.2	103.7	102.4	100.2	99.5	98.6	91.1	90.7	93.1				2.91	3.04	3.06
	2 Cleanup bef.min C/B	N/A	105.1	105.1	105.1	109.5	107.6	107.5	105.2	103.7	102.4	100.3	99.5	98.4	90.7	91.9	93.5				2.93	3.07	3.03
	3a Max C/B bef.Cleanup	3050	105.1	105.1	105.1	106.5	106.1	107.5	103.7	99.8	102.2	100.7	97.5	94.2	97.6	94.9	92.0				3.18	2.77	2.65
	3b Max C/B bef.Cleanup	915	105.1	105.1	105.1	106.5	106.1	107.5	103.7	99.8	102.2	100.7	97.5	94.2	97.6	94.9	92.0				3.19	2.75	2.76
	4 Min C/B bef.Cleanup	N/A	105.1	105.1	105.1	110.5	107.6	107.5	102.9	102.3	102.4	99.3	97.4	96.9	95.6	94.4	92.0				2.77	2.71	2.87

*Contour is not closed.

TABLE A-12: DATA SUMMARY FOR B747-200 AT 775,000 LBS.

QUANTITY			Distance to Closure (Kilometers)			Area (Sq. Kilometers)			Population X (1000)			Population Y (1000)			Population Z (1000)			Airport/Runway Weighted Tot.Pop.(mil.)			Airport/Runway Level Weighted Pop. (mil.)		
	Initiation Altitude		122	305	610	122	305	610	122	315	610	122	305	610	122	305	610	122	305	610	122	305	610
Noise Level (EPNL)	PROCEDURE	Resume Climb Power Alt(M)																					
85	1a Cleanup bef.max C/B	3050	35.3	34.2	34.6	95.0	94.6	103.	384.	398.	421.	61.0	62.7	67.5	15.0	15.6	16.5	13.2	13.5	14.6	.782	.843	.905
	1b Cleanup bef.max C/B	915	35.1	34.0	33.1	96.4	95.7	99.8	385.	399.	418.	61.1	62.9	66.7	15.0	15.6	16.4	13.2	13.6	14.4	.785	.850	.886
	2 Cleanup bef.min C/B	N/A	34.3	33.5	33.0	95.4	99.1	99.9	386.	411.	418.	61.3	65.5	66.9	15.1	16.1	16.4	13.2	14.1	14.5	.785	.758	.880
	3a Max C/B bef.Cleanup	3050	-*	-*	-*	129.*	128.*	125.*	364.*	386.*	427.*	67.9*	70.5*	74.9*	14.9*	15.9*	17.2*	14.7	15.2	1.62	.926	1.04	1.24
	3b Max C/B bef.Cleanup	915	-*	-*	-*	129.*	128.*	125.*	364.*	386.*	425.*	67.8*	70.5*	74.3*	14.9*	15.9*	17.1*	14.6	15.2	16.0	.917	1.04	1.22
	4 Min C/B bef.Cleanup	N/A	40.5	39.9	39.5	105.	107.	109.	357.	390.	411.	60.7	64.7	67.0	14.4	15.5	16.2	13.1	14.0	14.5	.825	.923	.951
90	1a Cleanup bef.max C/B	3050	21.4	20.5	21.2	46.3	46.0	51.1	243.	242.	255.	35.5	35.2	38.0	9.52	9.48	9.99	7.67	7.60	8.21	.950	.916	.984
	1b Cleanup bef.max C/B	915	21.8	20.9	20.8	46.3	46.1	51.0	243.	242.	245.	35.5	35.2	37.8	9.52	9.48	9.94	7.67	7.60	8.16	.950	.916	.973
	2 Cleanup bef.min C/B	N/A	21.8	21.2	21.0	47.0	50.4	51.2	243.	253.	255.	35.7	37.8	38.2	9.56	9.95	10.0	7.71	8.16	8.25	.944	.984	1.01
	3a Max C/B bef.Cleanup	3050	38.9	35.7	29.5	65.0	59.4	50.8	222.	223.	224.	37.7	36.5	34.4	8.90	9.09	9.02	8.14	7.88	7.43	1.13	1.16	1.14
	3b Max C/B bef.Cleanup	915	39.4	36.2	30.0	65.2	59.6	51.1	223.	223.	224.	37.9	36.6	34.5	8.94	9.09	9.04	8.19	7.91	7.45	1.14	1.17	1.14
	4 Min C/B bef.Cleanup	N/A	27.0	26.5	25.7	50.0	50.1	49.5	220.	227.	240.	33.8	34.6	36.0	8.89	9.12	9.51	7.30	7.47	7.78	.984	1.05	1.07
95	1a Cleanup bef.max C/B	3050	15.5	15.9	18.1	26.7	27.0	29.0	137.	139.	145.	18.9	19.2	20.8	5.46	5.53	5.80	4.08	4.15	4.49	.964	1.05	1.31
	1b Cleanup bef.max C/B	915	15.5	15.9	18.1	26.7	26.9	29.0	137.	139.	145.	18.9	19.2	20.8	5.46	5.53	5.80	4.08	4.15	4.49	.964	1.05	1.33
	2 Cleanup bef.min C/B	N/A	15.6	17.5	18.3	26.7	28.6	28.7	139.	145.	144.	19.2	20.6	20.6	5.53	5.78	5.75	4.15	4.45	4.45	.994	1.19	1.31
	3a Max C/B bef.Cleanup	3050	23.2	19.7	13.2	27.4	23.5	20.9	118.	112.	106.	17.9	16.2	14.5	4.72	4.64	4.46	3.87	3.50	3.13	1.24	1.08	.726
	3b Max C/B bef.Cleanup	915	23.2	19.6	13.2	27.4	23.5	20.9	118.	112.	106.	17.9	16.2	14.5	4.72	4.64	4.46	3.87	3.50	3.13	1.24	1.08	.726
	4 Min C/B bef.Cleanup	N/A	18.9	15.5	14.3	24.3	22.8	24.4	117.	119.	127.	16.6	16.3	17.3	4.86	4.89	5.10	3.59	3.52	3.74	.953	.843	.961
100	1a Cleanup bef.max C/B	3050	11.7	12.9	11.5	13.7	12.8	11.6	67.0	62.2	54.8	9.11	8.52	7.54	2.80	2.65	2.42	1.97	1.84	1.63	1.06	1.04	.915
	1b Cleanup bef.max C/B	915	13.7	12.9	11.4	13.4	12.8	11.5	67.0	62.2	53.4	9.11	8.52	7.33	2.80	2.65	2.38	1.97	1.84	1.58	1.06	1.04	.882
	2 Cleanup bef.min C/B	N/A	13.7	12.9	11.3	13.3	12.8	11.3	66.9	62.2	53.4	9.11	8.52	7.33	2.80	2.65	2.38	1.97	1.84	1.58	1.06	1.04	.882
	3a Max C/B bef.Cleanup	3050	14.3	10.5	10.6	10.9	9.37	11.2	37.5	36.3	52.0	5.27	5.20	7.13	1.66	1.80	2.33	1.14	1.12	1.54	.526	.615	.850
	3b Max C/B bef.Cleanup	915	14.3	10.5	10.6	10.9	9.37	11.2	37.5	36.3	52.0	5.27	5.20	7.13	1.66	1.80	2.33	1.14	1.12	1.54	.526	.615	.850
	4 Min C/B bef.Cleanup	N/A	10.3	11.3	11.8	11.2	12.1	11.6	50.6	56.8	54.8	6.92	7.74	7.54	2.28	2.48	2.42	1.49	1.67	1.63	.750	.913	.915
105	1a Cleanup bef.max C/B	3050	9.33	8.52	8.07	6.45	5.85	5.70	16.9	13.4	11.6	2.33	1.91	1.70	.777	.664	.604	.503	.413	.367	.293	.244	.195
	1b Cleanup bef.max C/B	915	9.33	8.52	8.07	6.45	5.85	5.70	16.9	13.4	11.6	2.33	1.91	1.70	.777	.664	.604	.503	.413	.367	.293	.244	.195
	2 Cleanup bef.min C/B	N/A	9.33	8.52	7.98	6.45	5.85	5.68	16.9	13.4	11.6	2.33	1.91	1.70	.777	.664	.604	.503	.413	.367	.293	.244	.195
	3a Max C/B bef.Cleanup	3050	8.70	7.17	7.98	5.52	5.37	5.68	13.4	8.08	11.6	1.91	1.27	1.70	.664	.485	.604	.413	.274	.367	.338	.095	.195
	3b Max C/B bef.Cleanup	915	8.70	7.17	7.98	5.52	5.37	5.68	13.4	8.08	11.6	1.91	1.27	1.70	.664	.485	.604	.413	.274	.367	.338	.095	.195
	4 Min C/B bef.Cleanup	N/A	9.06	8.52	8.07	6.39	5.85	5.70	15.2	13.4	11.6	2.13	1.91	1.70	.724	.664	.604	.460	.413	.367	.246	.244	.195
110	1a Cleanup bef.max C/B	3050	6.63	6.09	6.09	4.51	4.29	4.29	6.76	5.45	5.45	1.07	.864	.864	.420	.355	.355	.231	.187	.187	.248	.180	.180
	1b Cleanup bef.max C/B	915	6.63	6.09	6.09	4.51	4.29	4.29	6.76	5.45	5.45	1.07	.864	.864	.420	.355	.355	.231	.187	.187	.248	.180	.180
	2 Cleanup bef.min C/B	N/A	6.63	6.09	6.09	4.51	4.29	4.29	6.76	5.45	5.45	1.07	.864	.864	.420	.355	.355	.231	.187	.187	.248	.180	.180
	3a Max C/B bef.Cleanup	3050	5.46	6.09	6.09	3.98	4.29	4.29	2.83	5.45	5.45	.459	.864	.864	.225	.355	.355	.099	.187	.187	.046	.180	.180
	3b Max C/B bef.Cleanup	915	5.46	6.09	6.09	3.98	4.29	4.29	2.83	5.45	5.45	.459	.864	.864	.225	.355	.355	.099	.187	.187	.046	.180	.180
	4 Min C/B bef.Cleanup	N/A	6.63	6.09	6.09	4.51	4.29	4.29	6.76	5.45	5.45	1.07	.864	.864	.420	.355	.355	.231	.187	.187	.248	.180	.180
115	1a Cleanup bef.max C/B	3050	4.92	4.92	4.92	2.55	2.55	2.55	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
	1b Cleanup bef.max C/B	915	4.92	4.92	4.92	2.55	2.55	2.55	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
	2 Cleanup bef.min C/B	N/A	4.92	4.92	4.92	2.55	2.55	2.50	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
	3a Max C/B bef.Cleanup	3050	4.83	4.92	4.92	2.51	2.55	2.55	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
	3b Max C/B bef.Cleanup	915	4.83	4.92	4.92	2.51	2.55	2.55	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
	4 Min C/B bef.Cleanup	N/A	4.92	4.92	4.92	2.55	2.55	2.55	1.90	1.90	1.90	.318	.318	.318	.158	.158	.158	.069	.069	.069	.144	.144	.144
			Sideline			Takeoff 1 (4700 M)			Takeoff 2 (6500 M)			Takeoff 3 (9200 M)			Takeoff 4 (12,000 M)						Total		
Certification Measurement (EPNL)	1a Cleanup bef.max C/B	3050	105.6	105.6	105.6	115.9	116.1	116.1	110.4	108.7	108.7	105.2	104.1	102.8	100.9	100.1	99.2				4.44	4.42	4.63
	1b Cleanup bef.max C/B	915	105.6	105.6	105.6	115.9	116.1	116.1	110.4	108.7	108.7	105.2	104.1	102.8	100.9	100.1	99.1				4.44	4.42	4.59
	2 Cleanup bef.min C/B	N/A	105.6	105.6	105.5	115.9	116.1	116.0	110.4	108.7	108.6	105.2	104.1	102.7	100.9	100.1	99.0				4.47	4.54	4.60
	3a Max C/B bef.Cleanup	3050	105.6	105.6	105.6	115.7	116.1	116.1	107.9	108.6	108.7	104.4	100.9	102.8	101.2	98.5	95.2				4.35	4.31	4.48
	3b Max C/B bef.Cleanup	915	105.6	105.6	105.6	115.7	116.1	116.1	107.9	108.6	108.7	104.4	100.9	102.8	101.2	98.5	95.2				4.35	4.32	4.46
	4 Min C/B bef.Cleanup	N/A	105.6	105.6	105.6	115.9	116.1	116.1	110.4	108.7	108.7	104.4	104.1	102.8	98.3	96.6	99.2				4.15	4.27	4.42

*Contour not closed.

APPENDIX B

PROFILE AND NOISE DATA SUMMARY

This appendix contains a condensed summary of selected profile and noise data for each of the six aircraft at each of two weights.

The profile data are given for five procedures:

- Cleanup before maximum cutback, beginning at 122 meters 1a)
- Cleanup before maximum cutback, beginning at 305 meters (1a)
- Cleanup before minimum cutback, beginning at 305 meters (2)
- Maximum cutback after cleanup, beginning at 305 meters (3a)
- Minimum cutback after cleanup, beginning at 305 meters (4).

For all procedures data are given for the length of takeoff roll, takeoff velocity and takeoff thrust for a single engine. Total takeoff thrust is obtained by multiplying the given thrust by the number of engines. The profile data include: altitude above a sea level runway, distance from the beginning of takeoff roll, indicated air speed and net thrust for a single engine normalized to sea level pressure (F_n/δ). The noise data are for a reference net sea level thrust at 160 knots.

For the first procedure (1a) data are given for two initiation altitudes for the point at which acceleration to permit cleanup is begun, the point at which cutback is initiated, and the distance to 1676 meters altitude. For the second procedure (2) data are given for the same points as in the first procedure and for the point at which final acceleration to 250 knots (beginning at an altitude of 914 meters) is completed. Data are not given for the (1b) procedures but they can be approximated for initiation at an altitude of 305 meters by combining appropriately the information given for procedures (1a) and (2) together with the distance to an altitude of 914 meters in Table 7.

Data for the third procedure (3a) are given for the point at which cutback is initiated and the distance to reach an altitude of 1676 meters. Data for the fourth procedure (4) are given at the points of beginning acceleration and initiating cutback, the point of ending acceleration, and the distance to an altitude of 1676 meters.

The profile data were developed in accordance with the methodology of reference B-1 and represent the information available in our files in the fall of 1979. As a result of a concurrent effort to update the profile for the integrated noise model some of the data used in this study have been revised, Reference B-2. The only significant change is a reduction in the drag ÷ lift relationship for the clean DC-10-10 which in this study is about 30% higher, due primarily to the nonretraction of the leading edge slats. This change would not affect procedure 3a, but would improve, relative to these data, the climb performance after cleanup for procedures 1, 2, 3b, and 4.

The noise data are based on reference B-3, but with a 6 log slant distance duration correction to the data at the 305 meter slant distance, instead of the 10 log slant distance duration correction used in deriving the tables of Reference A-3. These data have also been updated in a concurrent effort, Reference B-4, which also employes the 6 log slant distance duration correction. The two noise data bases are within approximately one-half decibel at 305 meter slant distance except for the DC 9-10 which is increased by 2.0 dB in the updated data base.

TABLE B-1:
PROFILE AND NOISE DATA SUMMARY FOR DC9-10 AIRCRAFT.

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. PROFILE						
Profile for gross takeoff weight of 80,000 lbs., T/O roll = 917. meters; T/O velocity - 134 knots; T/O F/δ = 11,895 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	1.5	134	11895	
	Cutback	438	4.2	187	6331	21.0
1a) Cleanup before max C/B	Begin Accel.	305	2.4	134	11895	
	Cutback	649	5.3	187	6493	19.0
2) Cleanup before min C/B	Begin Accel.	305	2.4	134	11895	
	Cutback	649	5.3	187	10712	
	End Accel.	1228	10.9	250	10712	13.8
3a) Max C/B before Cleanup	Cutback	305	2.4	134	7498	20.9
4) Min C/B before Cleanup	Begin Accel.	305	2.4	134	11895	
	Cutback	390	3.0	144	10712	
	End Accel.	1210	11.3	250	10712	14.4
Profile for gross takeoff weight of 90,700 lbs., T/O roll = 1179 meters; T/O velocity = 142 knots; T/O F/δ = 11895 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	1.9	142	11895	
	Cutback	453	5.4	199	7198	22.2
1a) Cleanup before max C/B	Begin Accel.	305	3.0	142	11895	
	Cutback	665	6.8	199	7385	20.3
2) Cleanup before min C/B	Begin Accel.	305	3.0	142	11895	
	Cutback	665	6.8	199	10712	
	End Accel.	1225	13.0	250	10712	16.5
3a) Max C/B before Cleanup	Cutback	305	3.0	142	8501	21.6
4) Min C/B before Cleanup	Begin Accel.	305	3.0	142	11895	
	Cutback	388	3.8	152	10712	
	End Accel.	1200	13.4	250	10712	17.1

B. NOISE

Reference Net Thrust 12,000 lbs @ 160 knots

Slant Distance (Meters)	305	610	960	1524	3048
EPNL	109.0	102.8	97.8	92.4	84.0

TABLE B-2:
PROFILE AND NOISE DATA SUMMARY FOR DC9-80 AIRCRAFT.

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. **PROFILE**						
Profile for gross takeoff weight of 112,000 lbs., T/O roll = 1395 meters; T/O velocity - 151 knots; T/O F/δ = 16060 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	2.0	151	16060	
	Cutback	350	3.9	187	10981	18.1
1a) Cleanup before max C/B	Begin Accel.	305	2.9	151	16060	
	Cutback	551	5.0	187	10736	16.7
2) Cleanup before min C/B	Begin Accel.	305	2.9	151	16060	
	Cutback	551	5.0	187	11812	
	End Accel.	1253	14.2	250	11812	18.9
3a) Max C/B before Cleanup	Cutback	305	2.9	151	8730	25.3
4) Min C/B before Cleanup	Begin Accel.	305	2.9	151	16060	
	Cutback	381	3.5	161	11812	
	End Accel.	1140	14.0	250	11812	19.9
Profile for gross takeoff weight of 140,000 lbs., T/O roll = 2183 meters; T/O velocity = 167 knots; T/O F/δ = 16060 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	3.0	167	16060	
	Cutback	351	5.6	199	11812	22.8
1a) Cleanup before max C/B	Begin Accel.	305	4.3	167	16060	
	Cutback	556	7.2	199	11812	22.0
2) Cleanup before min C/B	Begin Accel.	305	4.3	167	16060	
	Cutback	556	7.2	199	11812	
	End Accel.	1332	21.0	250	11812	26.9
3a) Max C/B before Cleanup	Cutback	305	4.3	167	10910	26.6
4) Min C/B before Cleanup	Begin Accel.	305	4.3	167	16060	
	Cutback	391	5.2	177	11812	
	End Accel.	1149	19.6	250	11812	28.4

B. **NOISE** *
Reference Net Thrust 16,000 lbs @ 160 knots

Slant Distance (Meters)	305	610	960	1524	3048
EPNL	102.2	96.1	91.6	86.6	78.1

*A recent update of the Aircraft Noise Data Base (Ref. A-1) indicates that these noise levels are low by 2 dB.

TABLE B-3:
PROFILE AND NOISE DATA SUMMARY FOR B727-100 AIRCRAFT.

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. **PROFILE** Profile for gross takeoff weight of 135,000 lbs., T/O roll = 1369 meters; T/O velocity - 146 knots; T/O F/δ = 11895 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	2.1	146	11895	
	Cutback	376	5.5	212	5815	34.6
1a) Cleanup before max C/B	Begin Accel.	305	3.2	146	11895	
	Cutback	563	6.7	212	5947	31.9
2) Cleanup before min C/B	Begin Accel.	305	3.2	146	11895	
	Cutback	563	6.7	212	10712	
	End Accel.	1115	12.3	250	10712	16.8
3a) Max C/B before Cleanup	Cutback	305	3.2	146	6481	46.5
4) Min C/B before Cleanup	Begin Accel.	305	3.2	146	11895	
	Cutback	376	3.9	155	10712	
	End Accel.	621	7.7	210	10712	17.4
Profile for gross takeoff weight of 160,000 lbs., T/O roll = 1923 meters; T/O velocity = 155 knots; T/O F/δ = 11895 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	2.9	155	11895	
	Cutback	396	8.4	230	7016	36.9
1a) Cleanup before max C/B	Begin Accel.	305	4.4	155	11895	
	Cutback	579	9.9	230	7016	34.8
2) Cleanup before min C/B	Begin Accel.	305	4.4	155	11895	
	Cutback	579	9.9	230	10712	
	End Accel.	975	14.7	250	10712	21.4
3a) Max C/B before Cleanup	Cutback	305	4.4	155	7681	47.7
4) Min C/B before Cleanup	Begin Accel.	305	4.4	155	11895	
	Cutback	365	5.3	164	10712	
	End Accel.	518	8.3	210	10712	21.0

B. **NOISE**
Reference Net Thrust 12,000 lbs @ 160 knots

Slant Distance (Meters)	305	610	960	1524	3048
EPNL	111.0	104.8	99.8	94.4	86.0

TABLE B-4:

PROFILE AND NOISE DATA SUMMARY FOR DC10-10 AIRCRAFT

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. **PROFILE** * Profile for gross takeoff weight of 370,000 lbs., T/O roll = 1673 meters; T/O velocity - 160 knots; T/O F/δ = 30,039 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	2.5	160	30039	
	Cutback	556	8.1	228	22188	24.6
1a) Cleanup before max C/B	Begin Accel.	305	3.8	160	30039	
	Cutback	782	10.0	228	22800	22.7
2) Cleanup before min C/B	Begin Accel.	305	3.8	160	30039	
	Cutback	782	10.0	228	26000	
	End Accel.	1165	15.3	250	26000	21.3
3a) Max C/B before Cleanup	Cutback	305	3.8	160	17680	44.9
4) Min C/B before Cleanup	Begin Accel.	305	3.8	160	30039	
	Cutback	352	4.4	170	28537	
	End Accel.	1206	17.3	250	28537	22.8
Profile for gross takeoff weight of 440,000 lbs., T/O roll = 2366 meters; T/O velocity = 173 knots; T/O F/δ = 30,039 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	3.5	173	30039	
	Cutback	497	11.1	245	24900	34.0
1a) Cleanup before max C/B	Begin Accel.	305	5.3	173	30039	
	Cutback	716	13.6	245	25200	31.5
2) Cleanup before min C/B	Begin Accel.	305	5.3	173	30039	
	Cutback	716	13.6	245	28537	
	End Accel.	926	16.1	250	28537	26.0
3a) Max C/B before Cleanup	Cutback	305	5.3	173	21025	46.7
4) Min C/B before Cleanup	Begin Accel.	305	5.3	173	30039	
	Cutback	396	6.6	183	28537	
	End Accel.	1128	19.7	250	28537	27.1
B. **NOISE** Reference Net Thrust 30,000 lbs @ 160 knots						
Slant Distance (Meters)		305	610	960	1524	3048
EPNL		102.0	95.3	90.6	85.5	77.0

*Recent update of profile data base in Ref. A-2 indicates that the drag ÷ lift for the clean condition is too high in these data, making the values in procedures 1, 2, and 4 slightly higher than they should be.

TABLE B-5: .
PROFILE AND NOISE DATA SUMMARY FOR 707-320B AIRCRAFT

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. **PROFILE** Profile for gross takeoff weight of 260,000 lbs., T/O roll = 1731 meters; T/O velocity - 160 knots; T/O F/δ = 14850 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	2.6	160	14850	
	Cutback	438	6.5	214	6780	43.6
1a) Cleanup before max C/B	Begin Accel.	305	3.9	160	14850	
	Cutback	648	8.2	214	6953	39.5
2) Cleanup before min C/B	Begin Accel.	305	3.9	160	14850	
	Cutback	648	8.2	214	13120	
	End Accel.	1145	14.2	250	13120	19.3
3a) Max C/B before Cleanup	Cutback	305	3.9	160	8346	49.8
4) Min C/B before Cleanup	Begin Accel.	305	3.9	160	14850	
	Cutback	396	4.9	170	13120	
	End Accel.	1420	17.6	250	13120	20.0
Profile for gross takeoff weight of 333,600 lbs., T/O roll = 2851 meters; T/O velocity = 179 knots; T/O F/δ = 14850 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	4.2	179	14850	
	Cutback	455	10.9	242	8753	47.7
1a) Cleanup before max C/B	Begin Accel.	305	6.3	179	14850	
	Cutback	670	13.6	242	8982	42.8
2) Cleanup before min C/B	Begin Accel.	305	6.3	179	14850	
	Cutback	670	13.6	242	13120	
	End Accel.	966	18.0	250	13120	27.8
3a) Max C/B before Cleanup	Cutback	305	6.3	179	10740	52.0
4) Min C/B before Cleanup	Begin Accel.	305	6.3	179	14850	
	Cutback	416	8.2	189	13120	
	End Accel.	1306	24.2	250	13120	29.6

B. **NOISE**

Reference Net Thrust 15,000 lbs @ 160 knots

Slant Distance (Meters)	305	610	960	1524	3048
EPNL	115.0	107.3	101.3	94.9	85.0

TABLE B-6:
PROFILE AND NOISE DATA SUMMARY FOR B747-200 AIRCRAFT.

PROCEDURE	ACTION	PROFILE DATA				Dist. to Alt.of 1676 (km) Meters
		ALT. (Meters)	DIST. (km)	VEL. (Knots)	F/δ (lbs)	
A. **PROFILE** Profile for gross takeoff weight of 625,000 lbs., T/O roll = 2200 meters; T/O velocity - 168 knots; T/O F/δ = 34520 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	3.1	168	34520	
	Cutback	558	9.4	238	18123	41.1
1a) Cleanup before max C/B	Begin Accel.	305	4.6	168	34520	
	Cutback	781	11.5	238	18620	35.8
2) Cleanup before min C/B	Begin Accel.	305	4.6	168	34520	
	Cutback	781	11.5	238	23954	
	End Accel.	1022	16.0	250	23954	26.6
3a) Max C/B before Cleanup	Cutback	305	4.6	168	20600	50.8
4) Min C/B before Cleanup	Begin Accel.	305	4.6	168	34530	
	Cutback	385	6.2	193	23954	
	End Accel.	998	20.5	250	23954	31.4
Profile for gross takeoff weight of 775,000 lbs., T/O roll = 3383 meters; T/O velocity = 186 knots; T/O F/δ = 34530 lbs.						
1a) Cleanup before max C/B	Begin Accel.	122	4.8	186	34530	
	Cutback	634	14.9	250	22733	44.0
1a) Cleanup before max C/B	Begin Accel.	305	6.9	186	34530	
	Cutback	698	15.4	250	22908	42.5
2) Cleanup before min C/B	Begin Accel.	305	6.9	186	34530	
	Cutback and End Accel.	698	15.4	250	23954	39.6
3a) Max C/B before Cleanup	Cutback	305	6.9	186	23954	68.3
4) Min C/B before Cleanup	Begin Accel.	305	6.9	186	34530	
	Cutback	515	11.2	240	23954	
	End Accel.	966	28.0	250	23954	46.2

B. **NOISE**
Reference Net Thrust 34,500 lbs @ 160 knots

Slant Distance (Meters)	305	610	960	1524	3048
EPNL	108.0	101.3	96.6	91.5	83.0

APPENDIX B

References

B-1 Galloway, W.J., J.F. Mills, A.P. Hays, "Data Base for Predicting Noise from Civil Aircraft: Flight Profile Prediction," Bolt Beranek and Newman Inc. Report No. 2746R, prepared for U.S. Environmental Protection Agency, Office of Noise Abatement and Control under EPA Contract 68-01-2265, March 1976.

B-2 Potter, R.C., J.F. Mills, "Aircraft Flight Profiles for Use in Aircraft Noise Prediction Models," Bolt Beranek and Newman Inc. Report No. 4594, prepared for DOT Transportation Systems Center, Cambridge, MA, January 1981.

B-3 Bishop, D.E., J.F. Mills, J.M. Beckmann, "Sound Exposure Level versus Distance Curves for Civil Aircraft," Bolt Beranek and Newman Inc. Report No. 2759R, prepared for U.S. Environmental Protection Agency, Office of Noise Abatement and Control under EPA Contract 68-01-2265, February 1976.

B-4 Bishop, D.E., J.M. Beckmann, "Civil Aircraft Noise Data for Computation of Aircraft Noise Contours," Bolt Beranek and Newman Inc. Report No. 4440, prepared for DOT Transportation Systems Center, Cambridge, MA, November 1980.